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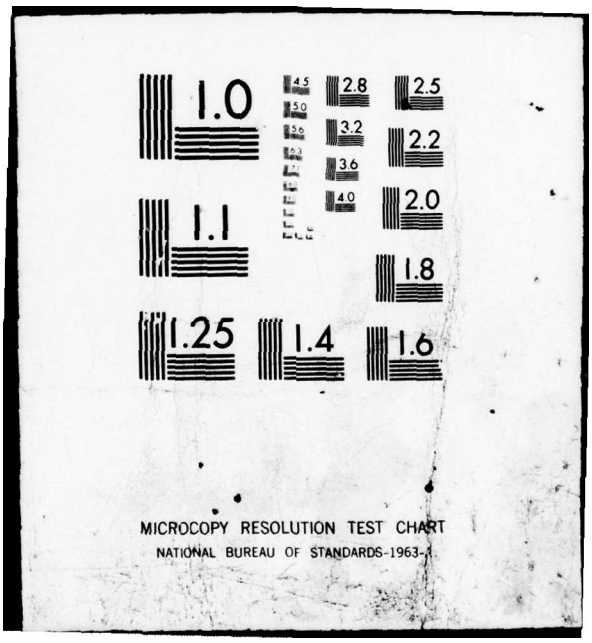
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DELAWARE RIVER BASIN

NESQUEHONING 4TH HOLLOW RESERVOIR

NDI NO. PA-00806
DER NO. 13-104

CARBON COUNTY, PENNSYLVANIA

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

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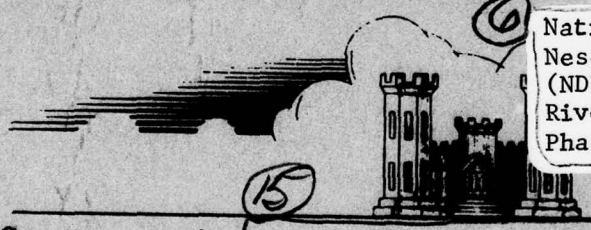


Contract # DACW31-79-C-0012

PREPARED FOR
DEPARTMENT OF THE ARMY
Baltimore District, Corps of Engineers
Baltimore, Maryland 21203

BY

Berger Associates, Inc.
Harrisburg, Pennsylvania

JULY 1979
84p.

PREFACE

This report has been prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through frequent inspections can unsafe conditions be detected and only through continued care and maintenance can these conditions be prevented or corrected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the spillway design flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The spillway design flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

PHASE I REPORT

NATIONAL DAM INSPECTION PROGRAM

BRIEF ASSESSMENT OF GENERAL CONDITIONS
AND RECOMMENDATIONS

Name of Dam:	NESQUEHONING 4TH HOLLOW RESERVOIR DAM
State & State No:	PENNSYLVANIA, 13-104
County:	CARBON
Stream:	BROAD RUN
Date of Inspection:	May 9, 1979

Based upon the visual inspection, historic performance, and the available engineering data and records, the dam and its appurtenant structures appear to be in good condition.

The hydrologic and hydraulic calculations indicate that the spillway for this dam has the capacity for passing the full Probable Maximum Flood (PMF) without overtopping the dam. On the basis of this information, the spillway capacity is considered to be adequate.

The following recommendations are presented for action by the owner:

1. That a study be performed by a professional engineer experienced in the design and construction of dams, to evaluate the adequacy of the conduit as a pressure line.

2. That the steel plate on the conduit outlet not be installed until the closure study has been completed.

3. That the barren areas on the downstream slope of the embankment be reseeded.

4. That the drawdown facility be operated on a semi-annual basis.

5. That the wet areas near the downstream toe be observed. If an increase in quantity or if turbidity would be detected, immediate steps should be taken to assure the safety of the dam.

6. That a method be developed for access to the facilities during periods of high discharges.

7. That a formal surveillance and downstream warning system be developed for use during periods of high or prolonged precipitation.

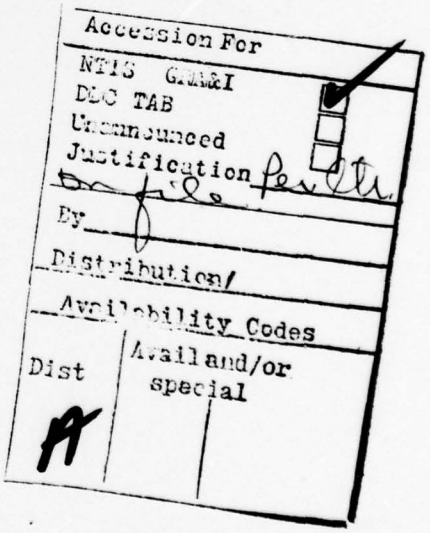
SUBMITTED BY:

BERGER ASSOCIATES, INC.
HARRISBURG, PENNSYLVANIA

DATE: July 13, 1979

APPROVED BY:

JAMES W. PECK
Colonel, Corps of Engineers
District Engineer
DATE 28 July 1979



OVERVIEW

NESQUEHONING 4TH HOLLOW RESERVOIR DAM

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PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

NESQUEHONING 4TH HOLLOW RESERVOIR DAM

NDI-ID NO. PA-00806
DER-ID NO. 13-104

SECTION I - PROJECT INFORMATION

1.1 GENERAL

A. Authority

The Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of inspections of dams throughout the United States.

B. Purpose

The purpose is to determine if the dam constitutes a hazard to human life and property.

1.2 DESCRIPTION OF PROJECT

A. Description of Dam and Appurtenances

ABSTRACT

The Nesquehoning 4th Hollow Reservoir Dam, originally known as the Broad Run Dam is a homogeneous earthfill dam with a maximum height of 51 feet above the downstream toe. The length of the earthfill is 300 feet ~~(see Appendix F, Plate III and V).~~ A 50-foot wide spillway is located in the right abutment. This spillway is an ogee type weir having a crest elevation 8.5 feet below the top of the spillway abutment walls. The forebay walls, spillway chute and stilling basin are all formed with concrete walls and slabs. An intake structure is located at the toe of the upstream slope of the embankment and has 4 sluice gates; three for water supply intake and one for drawdown purposes. The conduit through the embankment is horseshoe shaped and has a well defined riprap protected downstream channel. At the exit of the conduit is a small basin with energy dissipators. The water supply intake is through a 16-inch C.I. pipe encased in concrete.

ABSTRACT

B. Location:

Borough of Nesquehoning, Carbon County
U.S.G.S. Quadrangle, Nesquehoning, PA
Latitude 40°-52.1', Longitude 75°-52.0'
Appendix F, Plates I and II

C. Size Classification: Intermediate (Height 51 feet, storage 148 acre-feet)

D. Hazard Classification: High (Refer to Section 3.1.E)

E. Ownership: Nesquehoning Borough Authority
P. O. Box 3
Nesquehoning, PA 18240

F. Purpose: Water Supply

G. Design and Construction History

The dam was designed by A.L. Wiesenberger Associates, Inc., Allentown, Pennsylvania. The original design was approved for construction by the Pennsylvania Department of Environmental Resources (PennDER) on March 13, 1968. This design consisted of a pervious earthfill on a pervious foundation. A butyl rubber lining was to be used on the upstream face of the dam and the reservoir bottom. Due to the considerable amount of hard stone in the valley bottom and in the proposed fill, punctures in the membrane could occur. The embankment was redesigned as a homogeneous earthfill, including a cutoff trench and a grout curtain (Appendix F, Plate IV). Construction by Exco Contractors, Inc., Clarks Summit, Pennsylvania, was started August 1973, and was completed January 1975.

1.3 PERTINENT DATA

A. Drainage Area (square miles)

From files:	1.7
Computed for this report:	1.8
Use:	1.8

B. Discharge at Dam Site (cubic feet per second)
See Appendix C for hydraulic calculations

Maximum known flood for this site estimated from records for the U.S.G.S. gaging station which is located 20 miles downstream from dam occurred on August 19, 1955 (before dam was constructed)	540
Outlet works low-pool outlet at pool Elev. 1,190.0	67
Outlet works at pool level Elev. 1,217.5 (spillway crest)	112

	Warm-water outlet at pool Elev. 1,217.5 (spillway crest)	1.4
	Spillway capacity at pool Elev. 1,226.0 (top of dam)	4,580
C.	Elevation (feet above mean sea level)	
	Top of dam	1,226.0
	Spillway crest	1,217.5
	Upstream portal invert (4.5' x 4.5' conduit)	1,185.0
	Downstream portal invert (4.5' x 4.5' conduit)	1,175.5
	Streambed at downstream toe - estimate	1,175.0
	Maximum tailwater (estimated)	1,180
D.	Reservoir (miles)	
	Length of normal pool	0.2
	Length of maximum pool	0.3
E.	Storage (acre-feet)	
	Spillway crest (Elev. 1,217.5)	80
	Top of dam (Elev. 1,226.0)	148
F.	Reservoir Surface (acres)	
	Top of dam (Elev. 1,226.0) - Estimate	8
	Spillway crest (Elev. 1,217.5)	6

G. Dam (Refer to Plate III through V, Appendix F for section and plan).

Type: Homogeneous earthfill with upstream rock riprap and downstream toe filter.

Length: 300 feet.

Height: 51 feet from streambed at toe.

Top Width: 17 feet (design).
14 feet (survey, Appendix A, Plate A-II)

Design Side Slopes: Upstream 3H to 1V
Downstream 2H to 1V

Zoning: None.

Cutoff: Trench with bottom width of 25 feet located on the upstream side of the centerline of the dam and excavated to depth as directed.

Grouting: Design plans indicate a zoned grouting up to 40 feet deep.

H. Outlet Facilities

The outlet facilities consist of a concrete intake tower located 120 feet upstream from the centerline of the dam and a 220-foot-long horseshoe shaped reinforced concrete outlet tunnel. Access to the tower is by means of a 111-foot-long, single span, steel truss walkway from the top of the dam. Water is released from the reservoir by opening a 48-inch sluice gate in the upstream face of the intake tower. The downstream end of the outlet tunnel is fitted with a reinforced concrete box with a two-foot square opening in the right side.

Water for domestic use in Nesquehoning is admitted to the intake tower through three 16-inch sluice gates with centerline elevations of 1,215.5, 1,205.5 and 1,201.5. These sluice gates are connected to a 16-inch diameter cast-iron riser pipe which delivers the water to a 16-inch diameter cast-iron supply line. The 16-inch supply line passes through the embankment and continues on to the town of Nesquehoning. At the downstream toe of the embankment, a gated 3-inch diameter tap is used to maintain the required minimum low flow in Broad Run.

I. Spillway

Type: Uncontrolled reinforced concrete modified ogee weir and channel cut into the right bank adjacent to the right end of the embankment. The weir and channel are bounded by vertical concrete walls.

Length of weir: 50 feet with vertical reinforced concrete walls.

Crest elevation: 1,217.5.

Upstream channel: The spillway approach channel is about 80 feet long and rises rather sharply from the reservoir bottom. It is deep and narrow and is bounded by concrete wingwalls which protect the embankment and the right bank hillside from erosion. It is paved with 2-foot riprap. The last 10 feet upstream from the weir has a concrete apron. The channel is 5 feet deep at the upstream side of the weir.

Downstream channel: Flow over the weir is carried in a rectangular shaped, reinforced concrete channel which drops 38 feet in a horizontal distance of 110 feet. The channel width is a constant 50 feet and the training walls are about 15 feet high.

At the bottom of the chute is an 18-inch vertical drop to a 58-foot long, 5-foot deep stilling basin. At the end of the stilling pool is a 3-foot drop to a steep channel lined with 2-foot diameter riprap.

J. Regulating Outlets

See Section 1.3.H.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

A. Hydrology and Hydraulics

The files of the Pennsylvania Department of Environmental Resources (PennDER) did not contain any hydrologic or hydraulic calculations relative to the design of this dam. The report on the application for construction by PennDER states that the required spillway capacity is 2,135 cfs, which would leave a freeboard of 3.5 feet.

B. Embankment

A report, dated June 30, 1972, by Fisher, Fang and Associates, Bethlehem, Pennsylvania, discussed the soil and foundation for the embankment. A sandstone rock outcrop was at the east (left) embankment abutment. However, a varying depth of pervious material (sand, gravel and boulders) was overlaying the rock in the valley and right hillside. The report contains the recommendation to excavate a cutoff trench to bedrock and to grout the bedrock at an initial stage spacing of twenty feet. The recommended borrow area for the dam was near the Gun Club, four miles from the dam site. The report discusses the recommended slopes and toe filter but there are no stability or seepage calculations. Only five test borings were made at the site. The report contains many laboratory and test data on soil samples from five different borrow areas (up to 25 miles away). The final borrow areas were located at about four miles east and west of the dam and no further information about the material is available.

At the request of PennDER, stability calculations for the embankment were made in 1973. Only the results of the drawdown condition are mentioned. A minimum factor of safety of 1.5 was found for a full height rapid drawdown.

C. Appurtenant Structures

There were no design criteria or design calculations available in the files of PennDER or in the office of the owner. However, the available construction drawings are adequate to review the design of these structures.

The spillway ogee section is a 9.5 foot wide section founded on rock at elevation 1195.0. This means that overburden up to 20 feet in depth was excavated and filled with concrete. The forebay walls are T-type walls. The spillway chute is designed as a U-shaped section with the chute slab thickened at the walls and projecting about four feet behind the wall.

The intake structure is a reinforced concrete tower founded on a spread footing. The tower is topped with a 6.6 x 7.0 foot platform and supports four operator stands.

2.2 CONSTRUCTION

As-built drawings were not located. A few progress reports indicated monthly percentage progress, but there were no records of grouting. No indications were found of special problems or deviations from the construction drawings. A few photographs taken during the construction indicate a neat organized job. The design engineer supplied a full time resident engineer during the construction period.

2.3 OPERATION

Records of operation are not maintained, except the ones which are affecting the water supply management. There are no records of high water in the reservoir. The representative of the Borough stated that several years ago the drawdown sluice gate was opened and could not be closed due to the presence of a log, which was subsequently removed by further opening. This experience, due to the limited available water supply, has caused a halt to the regular operation of this gate.

2.4 EVALUATION

A. Availability

The data, on which this report is based, was obtained from the files of PennDER. Most of this information is also available in the office of the Borough Water Authority in Nesquehoning. The designer stated that additional information is not in his office.

B. Adequacy

1. Hydrology and Hydraulics

The available information is considered inadequate to review the design criteria for these facilities. However, the available construction drawings and the field inspection reports are adequate to review the safety of the structure.

2. Embankment

The design report states that a factor of safety for the sudden drawdown condition was 1.5, which is considered to be adequate. A review of the design slopes indicate an adequately designed embankment for a homogeneous earthfill.

3. Appurtenant Structures

The construction drawings are considered to be adequate to review the design of the appurtenant structures.

C. Operating Records

The facilities were completed in January 1975, and no records of operation are maintained. No special problems have occurred in the short period since the dam was completed.

D. Post Construction Changes

During the drought in 1975, it was decided by the owners to encase the end of the conduit with a concrete structure. This structure has a 12-inch pipe connected to the water supply line and a 24-inch x 24-inch opening which can be closed off with a steel plate (Refer to Appendix E, Plate E-I). When the upstream drawdown sluice gate is opened and this plate is installed, water can be taken out of the reservoir when the pool level falls below the lowest normal intake. Under this condition, the conduit is under pressure.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

A. General

The general appearance of this dam is good. The crest and upstream slope are in good condition. The downstream slope needs additional vegetation for protection. Two wet areas downstream of the dam were noticed, but they appear not to effect the embankment. Refer to Section 3.1.B for further discussion.

The visual inspection check list is in Appendix A of this report. This appendix also contains sketches of the survey information. Photographs taken during the inspection are reproduced in Appendix E.

B. Embankment

The upstream slope was in excellent condition and well protected with heavy riprap. The breast of the dam was level and above the spillway walls (Plate A-II, Appendix A), and covered with gravel. The downstream slope has little or no vegetation in several places, mainly caused by trail bikes. The Borough has installed several fences to discourage this misuse of the facilities. The Borough representative stated that reseeding of the barren spots was planned.

A wet area was located between the outlet structure and stilling basin. No flow of water was detected and it appears that only minor seepage is occurring at this point. An additional wet area was observed on the left hillside downstream of the stilling basin. It appears that this water is coming from the hillside and not from the embankment or dam abutment.

C. Appurtenant Structures

The spillway is located in the right abutment of the dam. The forebay is well protected with heavy riprap and the right forebay wall is butted far into the hillside. Although the approach width appears to be skewed awkwardly and relatively narrow, sufficient width and depth appears to be available during high water. The concrete of the ogee section was in good condition with only one small crack. The walls of the spillway chute and stilling basin are high and will certainly contain any flow over the spillway. All concrete was in good condition.

The intake tower is located near the upstream toe of the dam and is accessible with a footbridge from the crest of the dam. The bridge, tower and sluice gate operator stands were all in good condition.

The drawdown sluice gate was not operated during the inspection. The owners have experienced problems closing this gate due to jamming of a log and did not wish to risk a reoccurrence.

The outlet structure was changed in 1975 during a serious drought, at which time the reservoir level dropped too low to use the normal water supply intake gates. To allow the use of water stored below the lowest intake, the Borough blocked off the exit of the conduit with a concrete structure (Appendix E, Plate E-II). This structure has a 12-inch pipe connecting directly to the water supply pipeline and a 24-inch square opening which was open at the time of inspection. This opening, located on the right side of this structure, can be closed off with a steel plate. A considerable reduction in the blowoff facilities has occurred (see Section 6 and Appendix E). A valved 3-inch line is located in the headwall. This minimum flow line is connected to the 16-inch supply line.

D. Reservoir Area

The reservoir area is wooded. Some siltation occurred in the first year after construction due to the removal of trees adjacent to the reservoir. Vegetation has stabilized the banks and it appears that the reservoir has adequate slopes.

E. Downstream Channel

The downstream channel is a natural stream over the first 5,000 feet, over which length the streambed drops about 230 feet. At this point it enters a valley and joins the Nesquehoning Creek. Opposite this junction is a housing development. An increase in the hazard to loss of life can be expected in this area if the dam would fail due to overtopping. The hazard category for the Nesquehoning 4th Hollow Reservoir Dam is considered to be "High".

3.2 EVALUATION

The dam and appurtenant structures all appear in good condition, with the exception of unprotected areas on the downstream slope which should be protected against erosion.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

The Nesquehoning 4th Hollow Reservoir Dam is a water supply source for the Borough of Nesquehoning. One of the intake sluice gates is normally open and water is taken from the reservoir through a 16-inch pipeline which runs through a chlorination building directly to the borough. The dam is visited by representatives of the owner on a daily basis. No records are maintained of the depth of flow over the spillway.

4.2 MAINTENANCE OF DAM

Trail bikes have caused considerable destruction of vegetation on the downstream slope. Fences have been erected to prevent trail bikes from entering this area and policing of the area has been increased. It was stated by the Borough representatives that seeding of these areas has been planned.

4.3 MAINTENANCE OF OPERATING FACILITIES

All operating facilities appear to be in good condition. However, the drawdown sluice gate is not operated at regular intervals. To insure an operable condition in case of an emergency, it is recommended that such a procedure be established.

4.4 WARNING SYSTEM

Representatives of the Borough stated that there is an agreement with the Civil Defense for warning persons living downstream in case of an emergency. The access road to the dam crosses the downstream channel twice. Each crossing consists of two large pipes, which will not be able to handle the maximum flow over the spillway, therefore no access by car will exist during or just prior to an emergency flooding event.

4.5 EVALUATION

Although the normal operational procedures are adequate, additional seeding of the downstream slope is required. The drawdown facilities should be operated at least once a year. Plans for emergency access and surveillance during periods of heavy or prolonged precipitation should be developed.

SECTION 5 - HYDROLOGY/HYDRAULICS

5.1 EVALUATION OF FEATURES

A. Design Data

The hydrologic and hydraulic analysis available from PennDER for Nesquehoning 4th Hollow Reservoir Dam was not very extensive. No area curve, frequency curve, unit hydrograph, design storm, design flood hydrograph or flood routings were in the file.

The project was designed around 1973 by a recognized engineering firm. It is noted that the spillway has an outflow capacity of 4,580 cfs for a drainage area of 1.8 square miles or 2,500 cfs per square mile.

PennDER approved the design on the basis that the spillway can pass a "C" curve discharge of 2,135 cfs with 3.5 feet of freeboard.

B. Experience Data

According to Mr. Angelo Oliveria, Supervisor of the water works, the greatest flow since completion of the dam occurred in 1975 when the depth of flow over the spillway weir was 2 inches. The project passed that small rise without any damage.

C. Visual Observations

On the date of the inspection, no conditions were observed that would indicate that the appurtenant structures of the dam could not operate satisfactorily during a flood event, until the dam is overtopped.

D. Overtopping Potential

Nesquehoning 4th Hollow Reservoir Dam has a total storage capacity of 148 acre-feet and an overall height of 51 feet above streambed, both referenced to the top of the dam. These dimensions indicate a size classification of "Intermediate". The hazard classification is "High" (see Section 3.1.E).

The recommended Spillway Design Flood (SDF) for a dam having the above classifications is the full Probable Maximum Flood (PMF). For this dam, the PMF peak inflow is 3,257 cfs (see Appendix C for inflow computations).

Comparison of the estimated PMF peak inflow of 3,257 cfs with the estimated spillway discharge capacity of 4,480 cfs indicates that a potential for overtopping of the Nesquehoning 4th Hollow Reservoir Dam does not exist.

E. Spillway Adequacy

Calculations show that the spillway carries the full PMF with about 1.5 feet of freeboard.

Since the spillway can handle the full PMF without overtopping, it is judged to be adequate.

The hydrologic analysis for this investigation was based upon existing conditions of the watershed. The effects of future development were not considered.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

A. Visual Observations

1. Embankment

The visual inspection of the embankment did not detect any signs of embankment instability. There were no indications of seepage from the embankment slopes. There was, however, a wet area between the stilling basin and outlet structure beyond the toe of the dam. No water movement was detected and the amount appeared to be minor. Reseeding of the downstream slope will be required over a large area to prevent erosion. Although the embankment was designed with a 0.5 foot camber, the field survey indicates that the dam was constructed nearly 1.5 feet higher. The downstream slope was measured at 2.2H to 1V rather than 2H to 1V. The upstream slope had heavy rock riprap and an exact slope was difficult to determine. A 6-inch drain pipe was installed probably from the left abutment to the downstream channel of the outlet.

2. Appurtenant Structures

The visual inspection of the appurtenant structures indicate that all facilities are in excellent condition. Only minor cracking of some joints was noticed in the spillway walls.

B. Design and Construction Data

1. Embankment

Review of the construction drawings indicate an adequately designed section, including a cutoff trench, grout curtain and a downstream toe filter drain. Construction data was limited and no records of grouting were located. There was, however, no indication of foundation or embankment seepage and it appears that the pervious foundation was adequately sealed off.

2. Appurtenant Structures

The cast-in-place concrete conduit has one foot deep cutoff collars at 10 foot centers. The 16-inch water supply line was incased in concrete. All facilities have an upstream control. The spillway walls are well reinforced and have a drainage blanket behind the wall and weepholes. The right forebay wall appears to be well anchored in the sidehill.

C. Operating Records

There are no formal operation records on file to judge the performance or behavior of this dam during periods of high flow.

D. Post Construction Changes

The modification made in 1975 to increase the available supply of water effects the drawdown capacity of the conduit. Although the outlet of the conduit is constricted, it is considered that the available opening is still adequate for its function. Conduits are normally sized for diversion during construction and are generally oversized for its drawdown purpose. Details of joints in the conduit are not indicated on the design drawing (Appendix F, Plate VIII). If the conduit was poured continuously with only construction joints and no expansion joints, the longitudinal steel in the conduit is adequate to withstand the internal pressure. The conduit should, however, be analyzed to assure that the conduit can function as a pressure line.

E. Seismic Stability

This dam is located in Seismic Zone 1 and it is considered that the static stability is sufficient to withstand minor earthquake-induced dynamic forces. No studies or calculations have been made to confirm this assumption.

SECTION 7 - ASSESSMENT AND RECOMMENDATIONS

7.1 DAM ASSESSMENT

A. Safety

The visual inspection, the review of available data and the historic records of this dam indicate that the dam is in good condition.

The results of the hydrologic and hydraulic analyses for the dam, in accordance with the Corps of Engineers' evaluation guidelines, indicates that the spillway capacity and reservoir storage are sufficient for passing the PMF without overtopping the dam. On the basis of this information the spillway is considered to be adequate.

B. Adequacy of Information

The historic information available for review and the information gathered during the field inspection of the dam are considered sufficiently adequate for making a reasonable assessment of the condition of this facility.

C. Urgency

It is considered important that immediate action be taken to carry out the recommendations presented for maintenance and operation of these facilities.

D. Necessity for Additional Studies

It is recommended that the owner submit engineering data to PennDER indicating the adequacy of the conduit as a pressure line, or remove the concrete structure at the end of the outlet conduit.

7.2 RECOMMENDATIONS

In order to assure the continued satisfactory operation of this dam, the following recommendations are presented for action by the owner:

A. Facilities

1. That a study be performed by a professional engineer experienced in the design and construction of dams, to evaluate the adequacy of the conduit as a pressure line.

2. That the steel plate on the conduit outlet not be installed until the above study has been completed.

3. That the barren areas on the downstream slope be protected against erosion by acceptable vegetation.

B. Operation and Maintenance Procedures

1. That the drawdown facility be operated on a regular schedule.

2. That a method be developed for emergency access to the facilities during periods of high discharges in the downstream channel.

3. That the wet area near the downstream toe be observed. If an increase in quantiy or if turbidity would be detected, immediate steps should be taken to assure the safety of the dam.

4. That a formal surveillance program and downstream warning system be developed to be used during periods of heavy or prolonged rainfall.

APPENDIX A

CHECKLIST OF VISUAL INSPECTION REPORT

CHECK LIST

PHASE I - VISUAL INSPECTION REPORT

PA DER # 13-104 NDI NO. PA-00 806

NAME OF DAM Nesquehoning 4th hollow Reservoir HAZARD CATEGORY High

TYPE OF DAM Homogeneous Earthfill

LOCATION Borough of Nesquehoning TOWNSHIP Carbon COUNTY, PENNSYLVANIA

INSPECTION DATE 5/9/79 WEATHER Sunny - Warm TEMPERATURE 70's - 80's

INSPECTORS:	OWNER'S REPRESENTATIVE(s):
R. Houseal (Recorder)	
A. Bartlett	Oliveria Angelo
R. Steacy	Dave Digilio
H. Jongsma	

NORMAL POOL ELEVATION: 1217.50 AT TIME OF INSPECTION:

BREAST ELEVATION: 1226.0 POOL ELEVATION: Spillway + 1/2"

SPILLWAY ELEVATION: 1217.50 TAILWATER ELEVATION:

MAXIMUM RECORDED POOL ELEVATION: Spillway + 2-1/2" (1975)

GENERAL COMMENTS:

Record set of construction drawings dated 1975 are with the Borough. Also construction specifications. No calculations in borough files. Dam attended every day. Warning system set up with Civil Defense. Capacity of dam - 27 million gallons.

NDI NO. PA-00 806

VISUAL INSPECTION
EMBANKMENT

	OBSERVATIONS AND REMARKS
A. SURFACE CRACKS	None on top.
B. UNUSUAL MOVEMENT BEYOND TOE	None observed.
C. SLOUGHING OR EROSION OF EMBANKMENT OR ABUTMENT SLOPES	None observed.
D. ALIGNMENT OF CREST: HORIZONTAL: VERTICAL:	Good. Refer to surveyed profile Appendix A, Plate A-II
E. RIPRAP FAILURES	None.
F. JUNCTION EMBANKMENT & ABUTMENT OR SPILLWAY	Left abutment with original ground - good. Right abutment with spillway walls - good.
G. SEEPAGE	Small wet area right side of outlet structure. No flow - moist - very green grass. Some seepage from right hill side, beyond spillway.
H. DRAINS	Refer to plans. 6" drain from left abutment.
J. GAGES & RECORDER	None.
K. COVER (GROWTH)	Top - 3/4" stone surface. Upstream - large conglomerate boulders (riprap) Downstream grass covered (short)

NDI NO. PA-00 806

VISUAL INSPECTION
OUTLET WORKS

	OBSERVATIONS AND REMARKS
A. INTAKE STRUCTURE	Concrete tower at upstream toe of dam.
B. OUTLET STRUCTURE	Concrete endwall with concrete energy block controlling blow of discharge. Maximum discharge through 24 x 23 inch opening at right angle.
C. OUTLET CHANNEL	Short rock lined channel to stream channel from spillway.
D. GATES	Downstream valves controlling the water supply. 48" drawdown sluice gate controlled by opening in concrete block poured to close off conduit. Three water intake gates.
E. EMERGENCY GATE	48" blowoff. See D above.
F. OPERATION & CONTROL	Site visited every day for water supply service. When reservoir was low, the drawdown sluice gate was used to provide water supply.
G. BRIDGE (ACCESS)	Steel truss bridge to intake structure.

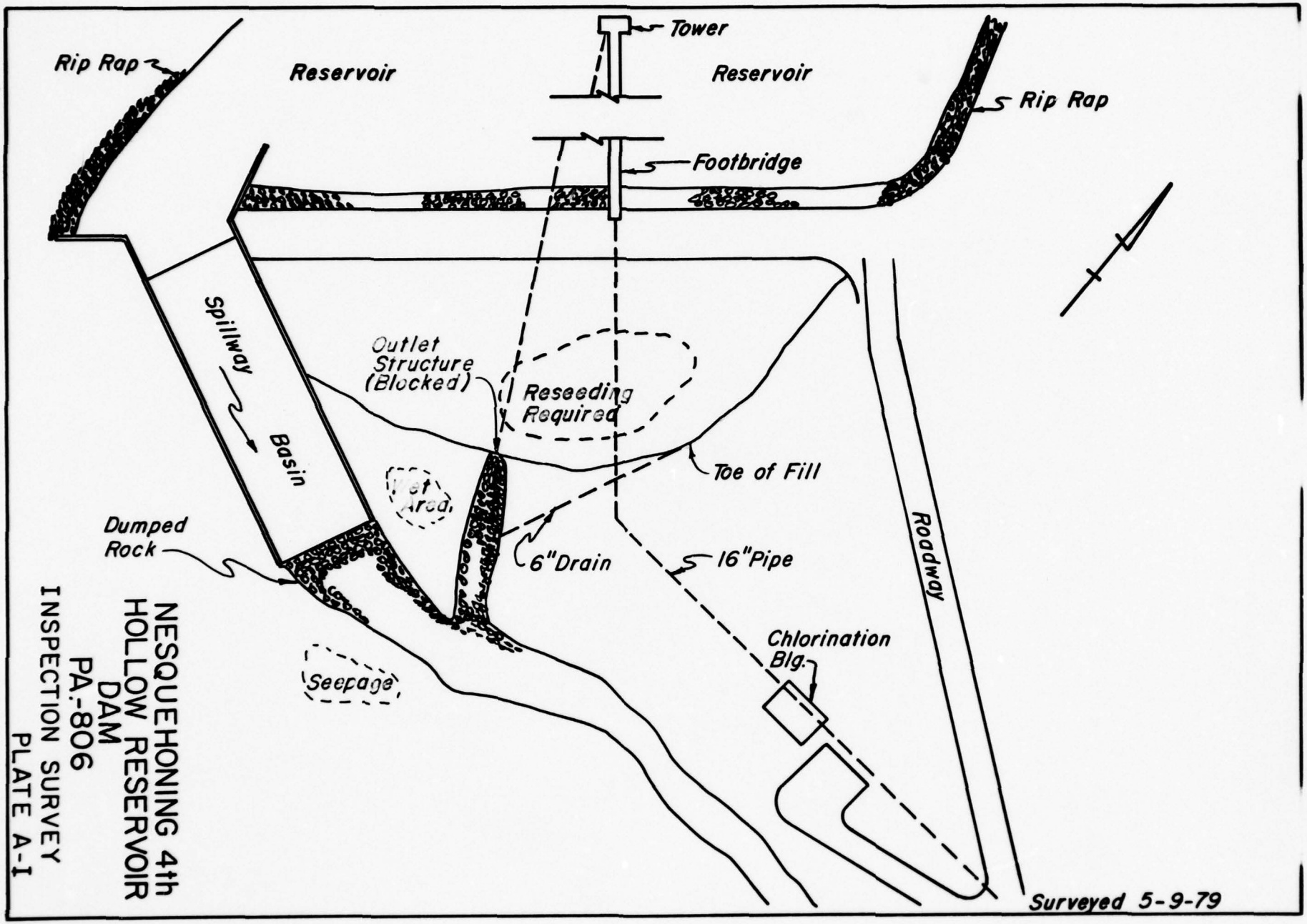
NDI NO. PA-00 806

VISUAL INSPECTION
SPILLWAY

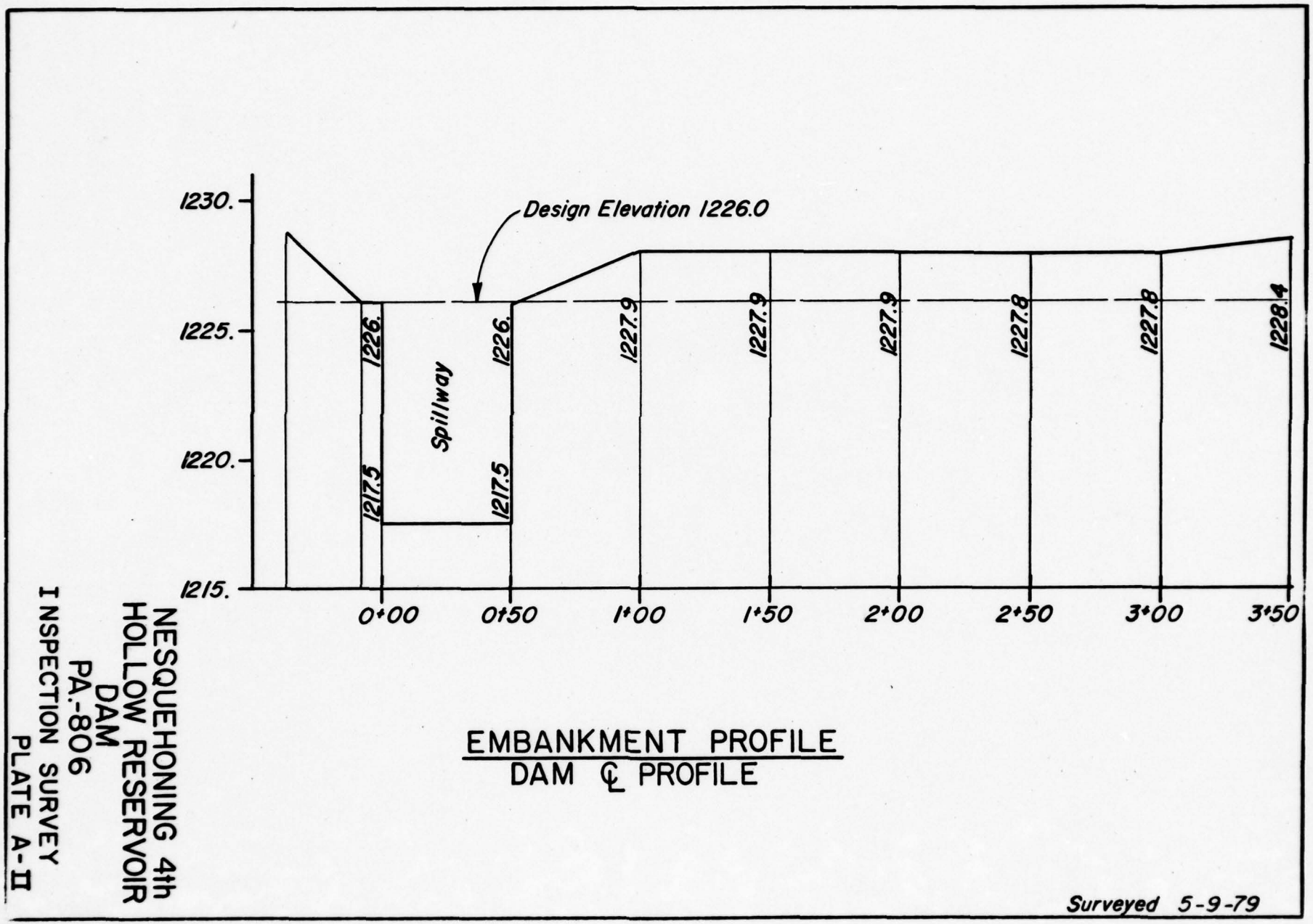
	OBSERVATIONS AND REMARKS
A. APPROACH CHANNEL	Right side of embankment - short channel from reservoir. Spillway wing on left. Riprap on natural slope on right. Approach not obstructed.
B. WEIR: Crest Condition Cracks Deterioration Foundation Abutments	Concrete Ogee. Good - Water flowing over spillway No deterioration - slight crack at top near joint. Not visible. Abutments good - slight deflection at construction joint. Right wall runs into hillside.
C. DISCHARGE CHANNEL: Lining Cracks Stilling Basin	Concrete slab with concrete walls to stilling basin. Walls in good condition. Some minor cracking. Natural stream below stilling basin.
D. BRIDGE & PIERS	None.
E. GATES & OPERATION EQUIPMENT	None.
F. CONTROL & HISTORY	No control.

VISUAL INSPECTION

	OBSERVATIONS AND REMARKS
INSTRUMENTATION	
Monumentation	None.
Observation Wells	None.
Weirs	None.
Piezometers	None.
Staff Gauge	None.
Other	None.
RESERVOIR	
Slopes	Timber - woodland.
Sedimentation	None reported.
Watershed Description	State Game Lands Woodlands.
DOWNSTREAM CHANNEL	
Condition	Natural mountain stream.
Slopes	Rocky, wooded.
Approximate Population	45
No. Homes	Hauto Estates - 15 Homes.



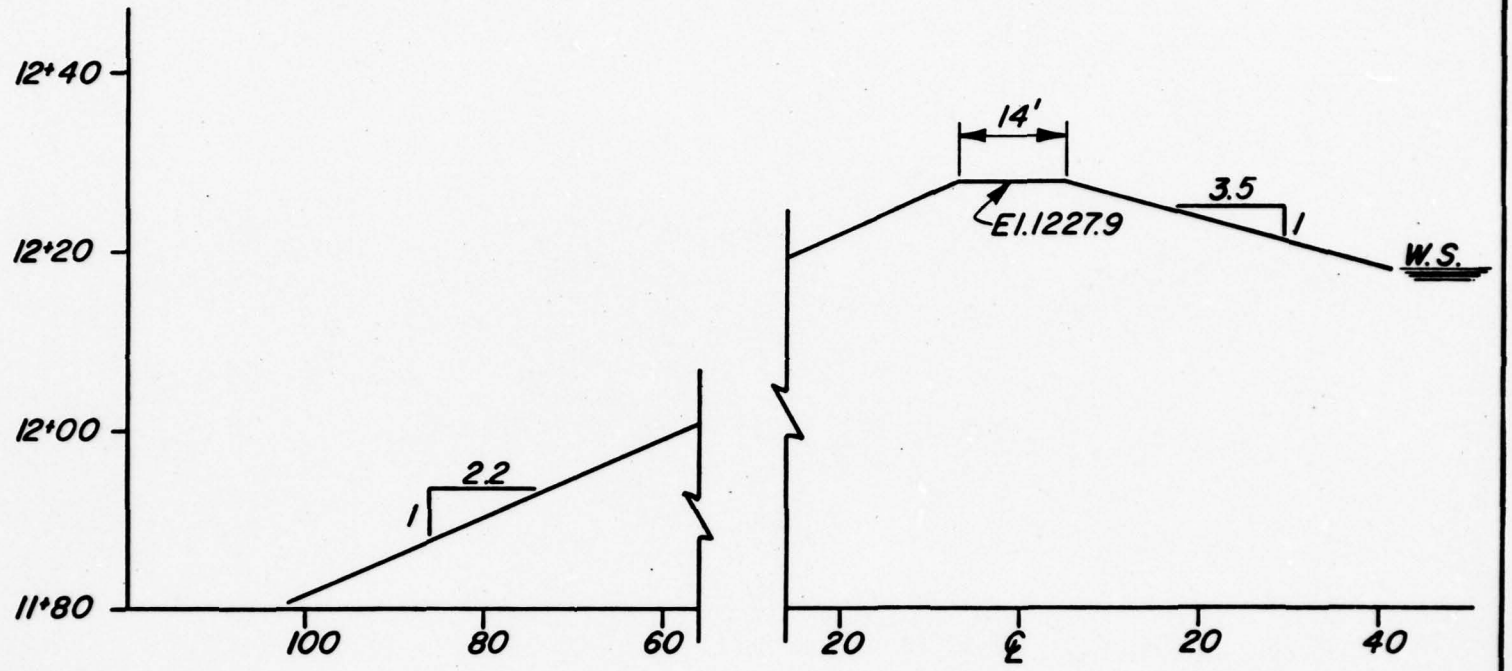
NESQUEHONING 4th
HOLLOW RESERVOIR
DAM
PA.-806
INSPECTION SURVEY
PLATE A-1



EMBANKMENT PROFILE
DAM ℄ PROFILE

Surveyed 5-9-79

NESQUEHONING 4th
HOLLOW RESERVOIR
DAM
PA.-806
INSPECTION SURVEY
PLATE A-II



EMBANKMENT SECTION

STA. 2+00

Surveyed 5-9-79

NESQUEHONING 4th
HOLLOW RESERVOIR
DAM
PA.-806
INSPECTION SURVEY
PLATE A-III

APPENDIX B

CHECKLIST OF ENGINEERING DATA

CHECK LIST
ENGINEERING DATA

PA DER # 13-104 NDI NO. PA-00 806

NAME OF DAM Nesquehoning 4th Hollow Reservoir

ITEM	REMARKS
AS-BUILT DRAWINGS	None.
REGIONAL VICINITY MAP	U.S.G.S. Quadrangle See Plate II, Appendix F
CONSTRUCTION HISTORY	Construction started in August, 1973 and completed January, 1975. Contractor: Exco Contractors, Inc., Clarks Summit, PA.
GENERAL PLAN OF DAM	See Appendix F, Plate III.
TYPICAL SECTIONS OF DAM	Appendix F, Plate V.
OUTLETS: PLAN DETAILS CONSTRAINTS DISCHARGE RATINGS	 See Appendix F, Plates III through VIII. Conduit partially blocked off in 1975. None.

ENGINEERING DATA

ITEM	REMARKS
RAINFALL & RESERVOIR RECORDS	None.
DESIGN REPORTS	Embankment Stability Report and Soil & Foundation Report by Fisher, Fang and Assoc., Bethlehem, PA (in PennDER Files)
GEOLOGY REPORTS	See above.
DESIGN COMPUTATIONS: HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES	 None. One page report by Fisher, Fang & Associates. None.
MATERIALS INVESTIGATIONS: BORING RECORDS LABORATORY FIELD	See Soil and Foundation Report.
POST CONSTRUCTION SURVEYS OF DAM	None.
BORROW SOURCES	Probably near Lake Hauto and near north end of Borough.

ENGINEERING DATA

ITEM	REMARKS
MONITORING SYSTEMS	None.
MODIFICATIONS	End of conduit blocked off partially during drought period. Maximum opening 24 inches square on side of conduit.
HIGH POOL RECORDS	None.
POST CONSTRUCTION ENGINEERING STUDIES & REPORTS	None.
PRIOR ACCIDENTS OR FAILURE OF DAM Description: Reports:	None.
MAINTENANCE & OPERATION RECORDS	None.
SPILLWAY PLAN, SECTIONS AND DETAILS	See Appendix F and PennDER files.

NDI NO. PA-00 806

ENGINEERING DATA

ITEM	REMARKS
OPERATING EQUIPMENT, PLANS & DETAILS	See construction drawings.
CONSTRUCTION RECORDS	Monthly progress reports with percentage complete. No details.
PREVIOUS INSPECTION REPORTS & DEFICIENCIES	None reported.
MISCELLANEOUS	

NDI NO. PA-00 806

CHECK LIST
HYDROLOGIC AND HYDRAULIC
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: Wooded Hills.

ELEVATION:

TOP NORMAL POOL & STORAGE CAPACITY: Elev. 1217.50 80 Acre-Feet

TOP FLOOD CONTROL POOL & STORAGE CAPACITY: Elev. 1226 148 Acre-Feet

MAXIMUM DESIGN POOL: Elev. 1222.50

TOP DAM: Elev. 1226.0

SPILLWAY:

a. Elevation 1217.50

b. Type Modified Ogee

c. Width 50 feet

d. Length 160 feet

e. Location Spillover Right abutment.

f. Number and Type of Gates None.

OUTLET WORKS:

a. Type Intake tower with 48-inch drawdown sluice gate and 4.5 foot horseshoe type conduit.

b. Location Toe of upstream slope.

c. Entrance inverts 1185.0

d. Exit inverts 1175.0

e. Emergency drawdown facilities 48-inch sluice gate. Conduit partially blocked.

HYDROMETEOROLOGICAL GAGES:

a. Type None.

b. Location

c. Records

MAXIMUM NON-DAMAGING DISCHARGE: Unknown.

APPENDIX C

HYDROLOGY AND HYDRAULIC CALCULATIONS

SUMMARY DESCRIPTION
OF
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION

The hydrologic and hydraulic evaluation for this inspection report has employed computer techniques using the Corps of Engineers computer program identified as the Flood Hydrograph Package (HEC-1) Dam Safety Version.

The program has been designed to enable the user to perform two basic types of hydrologic analyses: (1) the evaluation of the overtopping potential of the dam, and (2) the capability to estimate the downstream hydrologic-hydraulic consequences resulting from assumed structural failures of the dam. A brief summary of the computation procedures typically used in the dam overtopping analysis is shown below.

- Development of an inflow hydrograph to the reservoir.
- Routing of the inflow hydrograph(s) through the reservoir to determine if the event(s) analyzed would overtop the dam.
- Routing of the outflow hydrograph(s) of the reservoir to desired downstream locations. The results provide the peak discharge, time of the peak discharge and maximum stage of each routed hydrograph at the outlet of the reach.

The output data provided by this program permits the comparison of downstream conditions just prior to a breach failure with that after a breach failure and the determination as to whether or not there is a significant increase in the hazard to loss of life as a result of such a failure.

The results of the studies conducted for this report are presented in Section 5.

For detailed information regarding this program refer to the Users Manual for the Flood Hydrograph Package (HEC-1) Dam Safety Version prepared by the Hydrologic Engineering Center, U. S. Army Corps of Engineers, Davis, California.

SHEET NO.

SUBJECT Nesquehoning 4th Hollow Dam ID No. PA 806

COMPUTED BY RES DATE May 15, 1979 CHECKED BY JJPJr

Maximum Known Flood

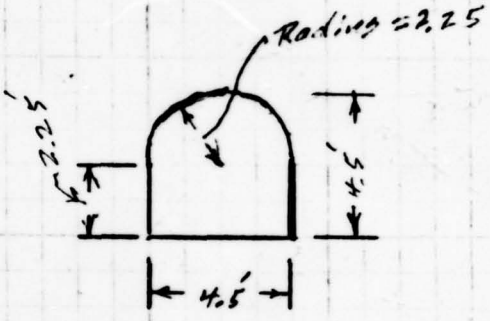
For the USGS gaging station, Lehigh River at Walnutport (889 mi²) which is downstream from this site, the maximum flood in the period 1946 to 1977 occurred on Aug. 19, 1955. The discharge was 77,800 cfs.

$$\left(\frac{1.8}{889}\right)^{0.8} \times 77{,}800 = 540 \text{ cfs}$$

Outlet Works

Blow Off

The outlet works consists of a concrete inlet tower located 120 feet upstream from the centerline of the dam and a 220-foot long horse shoe shaped outlet tunnel. Access to the tower is by means of a 111-foot-long, single-span, steel-truss walkway.



Water is released by opening a 48-inch sluice gate in upstream face of inlet tower. (Invert of sluice gate is 1185.0 feet elevation. Invert downstream end of conduit = 1175.5 Elev.

The downstream end of the outlet tunnel is fitted with a concrete-box type enclosure. The opening in the box is on the right side, is rectangular in cross section and measures 23 inches by 24 inches.

The areas of the various sections then are as follows:

48-inch sluice =

$$\pi R^2 = \pi \times (2)^2 = 12.57 \text{ ft}^2$$

PROJECT Dam Investigation SHEET NO. 6 OF

SUBJECT Nesquehoning 4th Hollow Dam, ID No. PA 806

COMPUTED BY RES DATE May 16 1979 CHECKED BY JJP

Outlet Works Cont.

Conduit

$$(4.5 \times 2.25) + \frac{\pi (2.25)^2}{2}$$

$$= 10.12 + 7.95 = 18.07 \text{ ft}$$

Box Structure Opening

23 inches x 24 inches

$= 1.92 \times 2.0 = 3.84$ ft

Compute pool elevation for 100 cfs

Sluice Gate $Q = C a \sqrt{2gh}$

$$100 = 0.6 \times 12.57 \times \sqrt{64.3 \times h}$$

$$\sqrt{64.3 \times h} = \frac{100}{0.6 \times 12.57} = 13.26$$

$$64.3 \times h = 176$$

$$h = 2.73 \text{ ft} \qquad 2.73$$

Tunnel

$$WP = 4.5 + (2 \times 2.25) + \frac{2\pi R}{2}$$

$$= 4.5 + 4.5 + (2.25 \times \pi)$$

$$= 16.07 \text{ ft}$$

$$r = \frac{a}{WP} = \frac{18.07}{16.07} = 1.12 \text{ ft}$$

$$V = \frac{100}{18.07} = \frac{1.486}{n} \times r^{2/3} \times S^{1/2} = 5.53$$

$$= \frac{1.486}{0.012} \times (1.12)^{2/3} \times S^{1/2}$$

$$= 124 \times 1.08 \times S^{1/2}$$

PROJECT _____ SHEET NO. _____

SUBJECT Nesquehoning 4th Hollow Dam, I.D No. PA 866

COMPUTED BY RES DATE May 16, 1979 CHECKED BY JJPJr.

Outlet Works Cont.

100 cfs, Tunnel Cont.

$$S^{1/2} = \frac{5.53}{124 \times 1.08} = 0.0413$$

$S = 0.0017$

$0.0017 \times 220 = 0.38$ ft 0.38

Outlet orifice

$$Q = c\,a\sqrt{2gh}$$

$$100 = 0.6 \times 3.84 \times \sqrt{64.3h}$$

$$\sqrt{64.3h} = \frac{100}{0.6 \times 3.84} = 43.4$$

$64.3h = 1884$

$h = 29.30$ 29.30

(To ℄ of orifice) $+1.0$

Pool Elev. (100 cfs) $= 1175.5 + 2.73 + .38 + 29.30$

$= 1208.9$

Compute Pool Elev. for 120 cfs

Sluice Gate

$$120 = 0.6 \times 12.57 \times \sqrt{64.3 \times h}$$

$$\sqrt{64.3h} = \frac{120}{0.6 \times 12.57} = 15.91$$

$64.3 \times h = 253$

$h = 3.94$ ft 3.94

Tunnel

$$V = \frac{120}{18.07} = 6.64 = 134\,S^{1/2}$$

$$S^{1/2} = \frac{6.64}{134} = 0.050, \quad S = 0.00246$$

PROJECT _____ SHEET NO _____

SUBJECT Nesquehoning 4-± Hollow Dam, ID No. PA-606

COMPUTED BY RES DATE May 16, 1979 CHECKED BY JJPJr

Outlet Works Cont.

120 cfs Tunnel Cont.

$S \times L = 0.00246 \times 220 = 0.54$ ft.

0.54

Outlet Orifice 120 cfs

$120 = 0.6 \times 3.84 \times \sqrt{64.3 \times h}$

$\sqrt{64.3 \times h} = \frac{120}{0.6 \times 3.84} = 52.1$

$64.3 \times h = 2713$

$h = 42.19$ ft 42.19

Pool Elev. (120 cfs) $= 1175.5^{+1.0} + 3.94 + 0.54 + 42.19$

$= 1223.2$

Compute Pool Elev. for 80 cfs

Sluice Gate

$80 = 0.6 \times 12.57 \times \sqrt{64.3h}$

$\sqrt{64.3h} = \frac{80}{0.6 \times 12.57} = 10.61$

$64.3h = 112.5$

$h = 1.75$ ft 1.75

Tunnel $V = \frac{80}{18.07} = 4.43 = 134\, S^{1/2}$

$S^{1/2} = \frac{4.43}{134} = 0.033$

$S = 0.00109$

Drop $= SL = 0.00109 \times 220$

$= 0.24$ ft 0.24

SUBJECT Nesquehoning 4th Hollow Dam ID No. PA-206 SHEET NO.

COMPUTED BY RES DATE May 16, 1979 CHECKED BY JJPJr

Outlet works cont.

Outlet Orifice 80 cfs

$$80 = 0.6 \times 3.84 \times \sqrt{64.3 \times h}$$

$$\sqrt{64.3h} = \frac{80}{0.6 \times 3.84} = 34.72'$$

$$64.3h = 1206$$

$$h = 18.75 \text{ ft} \qquad 18.75$$

Pool Elev. 80 cfs $= 1175.5 + 1.75 + 0.24 + 18.75$ (+1.0)

$= 1197.2'$

Compute Pool Elev. for 40 cfs

Outlet Orifice 40 cfs

$$40 = 0.6 \times 3.84 \times \sqrt{64.3h}$$

$$\sqrt{64.3h} = \frac{40}{0.6 \times 3.84} = 17.36$$

$$h = 4.69 \text{ ft}$$

(40 cfs)

Tunnel $V = \frac{40}{18.07} = 2.21$ ft/sec.

$$2.21 = \frac{1.486}{n} \times r^{2/3} \times S^{1/2}$$

$$= \frac{1.486}{0.012} \times (1.12)^{2/3} \times S^{1/2}$$

$$= 133.6 \times S^{1/2}$$

$$S^{1/2} = \frac{2.21}{133.6} = 0.0165$$

$$S = 0.000274$$

$$0.000274 \times 220 = 0.06 \text{ ft}$$

PROJECT _____ SHEET NO. 4

SUBJECT Nesquehoning 4½ Hollow Dam I.D. No. PA-00

COMPUTED BY RES DATE May 24, 1979 CHECKED BY JJP

Outlet works-Cont.

Pool Elev. 40 cfs cont.

Water Elev. in tunnel for 40 cfs

Elev = 1175.5 + 1.0 + 4.69 + 0.06 = 1181.25.
(Below invert of gate)

Sluice Gate

For ease in computation, assume gate is rectangle with area and height equal to that of gate.

Area = 12.57 = 4.0 × width

$$\text{Width} = \frac{12.57}{4.0} = 3.14 \text{ ft.}$$

As weir, $Q = C L H^{3/2}$

$C = 3.30$, $L = 3.14$

$$40 = 3.30 \times 3.14 \times (H)^{3/2}$$

$$H^{3/2} = \frac{40}{3.30 \times 3.14} = 3.86$$

$H = 2.46$ ft

Pool Elev. (40 cfs) = 1185.0 + 2.46 = 1187.5

PROJECT Dam Investigations SHEET NO. 1

SUBJECT Nesquehoning #1 Fallow Dam ID No. PA-806

COMPUTED BY RES DATE May 15, 1979 CHECKED BY JJPJ.

Outlet Works Cont.

Warm-Water outlet

Water for domestic use is conveyed to the inlet tower through 16-inch sluice gates with centerline elevations of 1215.5, 1205.5, and 1201.5. These sluice gates are connected to a 16-inch cast iron riser pipe which delivers the water to a 16-inch cast iron supply line. The 16-inch supply line passes through the embankment and continues on to the town of Nesquehoning. At the downstream toe of the embankment, a gated 3-inch tap is used to maintain low flow to Broad Run

Compute maximum discharge of tap as an orifice

$$Q = Ca\sqrt{2gh}$$

$C = 0.6 \quad a = \pi r^2 = \pi\left(\frac{4.5}{12}\right)^2 = 0.049 \text{ ft}^2$

$h = 1217.5 - 1175.5 = 42 \text{ ft.}$

$$Q = 0.6 \times 0.049 \times \sqrt{64.3 \times 42}$$

$= 1.53$

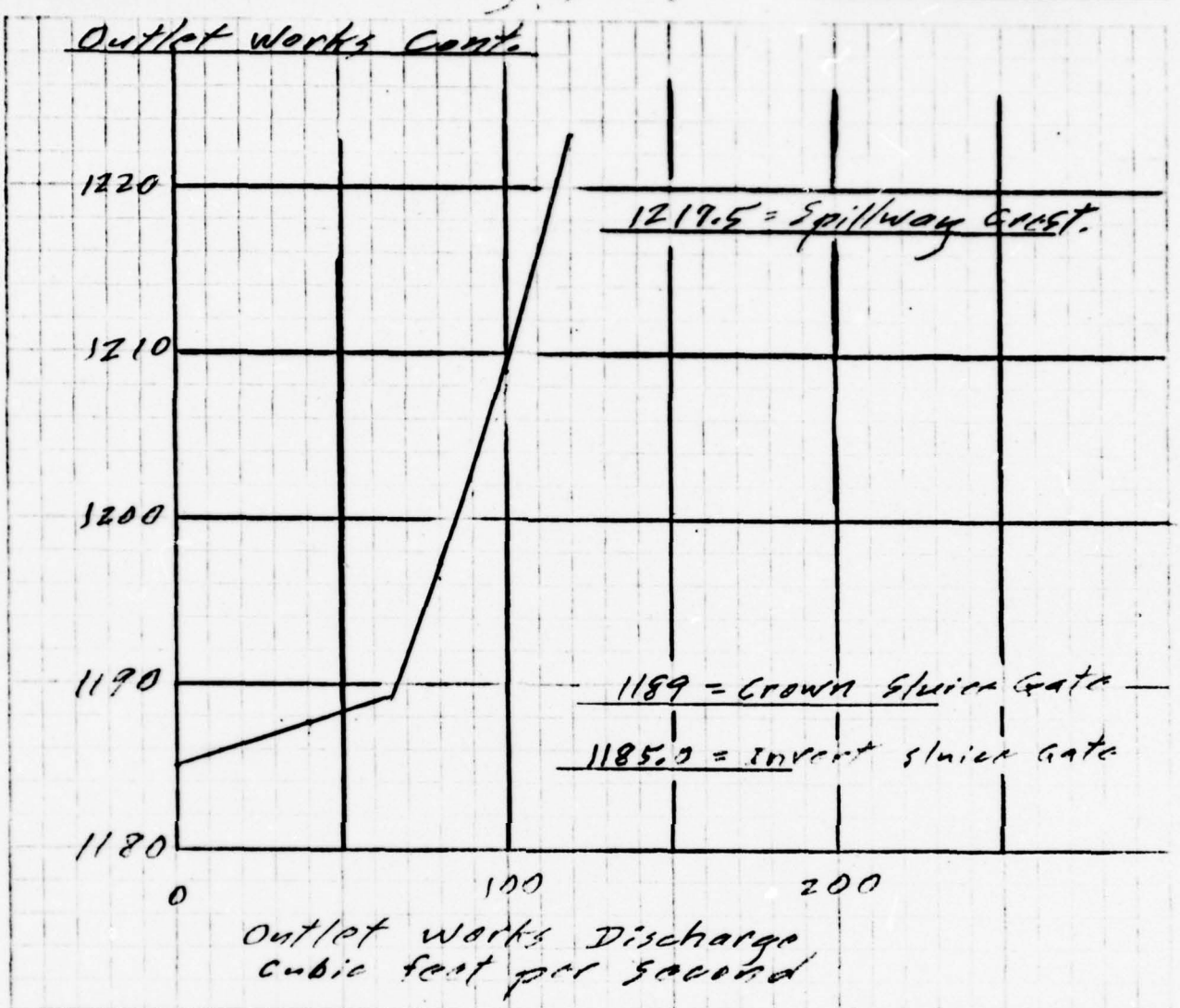
Say 1.4 cfs

PROJECT [illegible] SHEET NO. 3

SUBJECT Nesquehoning 4-ft Holland, ID Va. PA 806

COMPUTED BY RES DATE May 15, 1979 CHECKED BY JJI

Outlet Works Cont.



Spillway Rating

$Q = C L H^{3/2}$

Use $C = 3.7$ Average of Bruster + King Table values

$L = 50'$

For design flow $H = 5'$

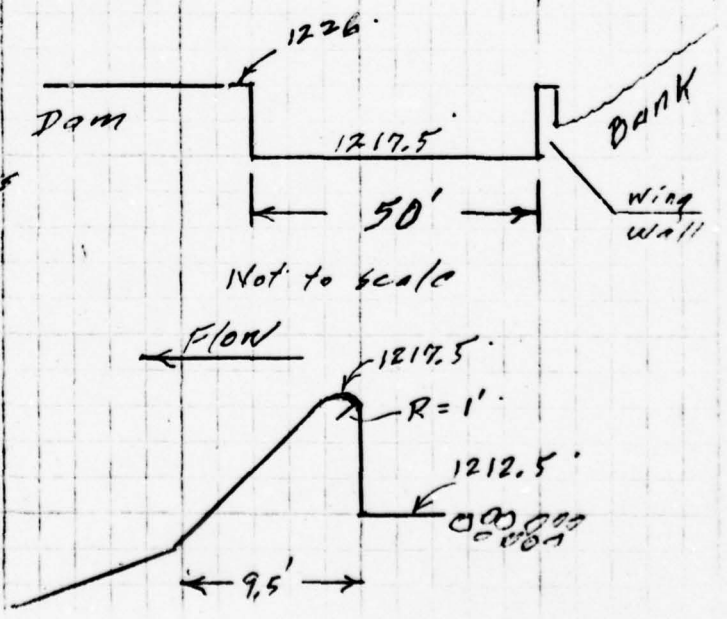
$Q = 3.7 \times 50 \times (5)^{3/2}$

$= 2,070$ cfs

For $H = 8.5$, $C = 3.7$

$Q = 3.7 \times 50 \times (8.5)^{1.5}$

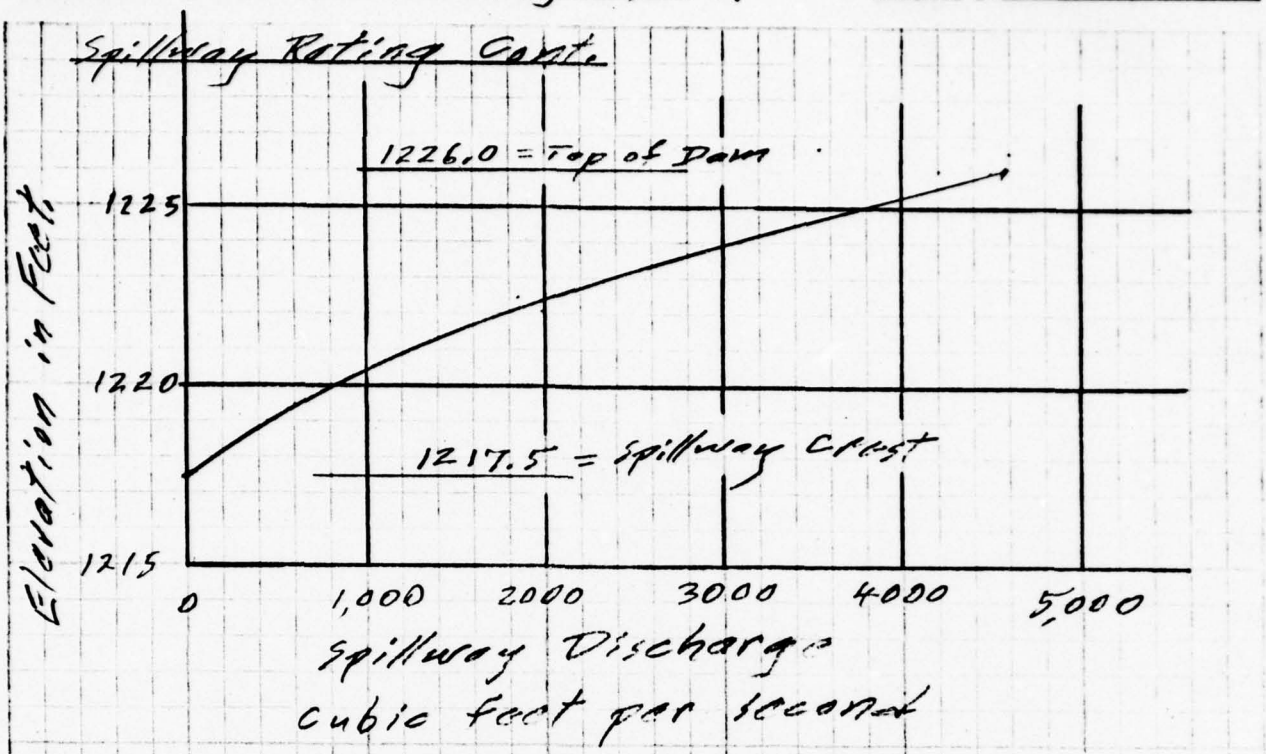
$= 4580$ cfs



PROJECT [illegible] SHEET NO. 1

SUBJECT Nesquehoning 4½ Hollow ID No. PA-806

COMPUTED BY RES DATE May 15, 1979 CHECKED BY JPS



BY RLS DATE 5/24/79 | BERGER ASSOCIATES | SHEET NO. 10 OF
CHKD. BY DATE | PROJECT 78490
SUBJECT NESQUEHONING 4TH HOLLOW DAM

EMBANKMENT RATING

$Q = C L H^{3/2}$, $C = 2.7$

ELEV. 1226.3

$2.7 \times 15 \times (.3)^{1.5} = 7$

$2.7 \times 8 \times (.15)^{1.5} = 1$ $\quad \Sigma = 8$ CFS

ELEV. 1226.7

$2.7 \times 15 \times (.7)^{1.5} = 24$

$2.7 \times 18 \times (.35)^{1.5} = 10$ $\quad \Sigma = 34$ CFS

ELEV. 1227.2

$2.7 \times 15 \times (1.2)^{1.5} = 53$

$2.7 \times 32 \times (.6)^{1.5} = 40$ $\quad \Sigma = 93$ CFS

ELEV. 1227.9

$2.7 \times 15 \times (1.9)^{1.5} = 106$

$2.7 \times 50 \times (.95)^{1.5} = 125$

$2.7 \times 50 \times (.1)^{1.5} = 4$ $\quad \Sigma = 235$ CFS

ELEV. 1228.9

$2.7 \times 15 \times (2.4)^{1.5} = 151$

$2.7 \times 50 \times (1.45)^{1.5} = 236$

$2.7 \times 50 \times (.6)^{1.5} = 63$

$2.7 \times 100 \times (.5)^{1.5} = 95$

$2.7 \times 50 \times (.55)^{1.5} = 55$

$2.7 \times 50 \times (.3)^{1.5} = 22$ $\quad \Sigma = 622$ CFS

BY RLS DATE 5/24/79 | BERGER ASSOCIATES | SHEET NO. 12 OF

CHKD. BY DATE | PROJECT D8490

SUBJECT NESQUEHONING 4TH HOLLOW DAM

SIZE CLASSIFICATION

MAXIMUM STORAGE = 148 ACRE-FEET

MAXIMUM HEIGHT = 51 FEET

SIZE CLASSIFICATION IS "INTERMEDIATE"

HAZARD CLASSIFICATION

SEVERAL HOUSES ARE NEAR THE DOWN STREAM CHANNEL.

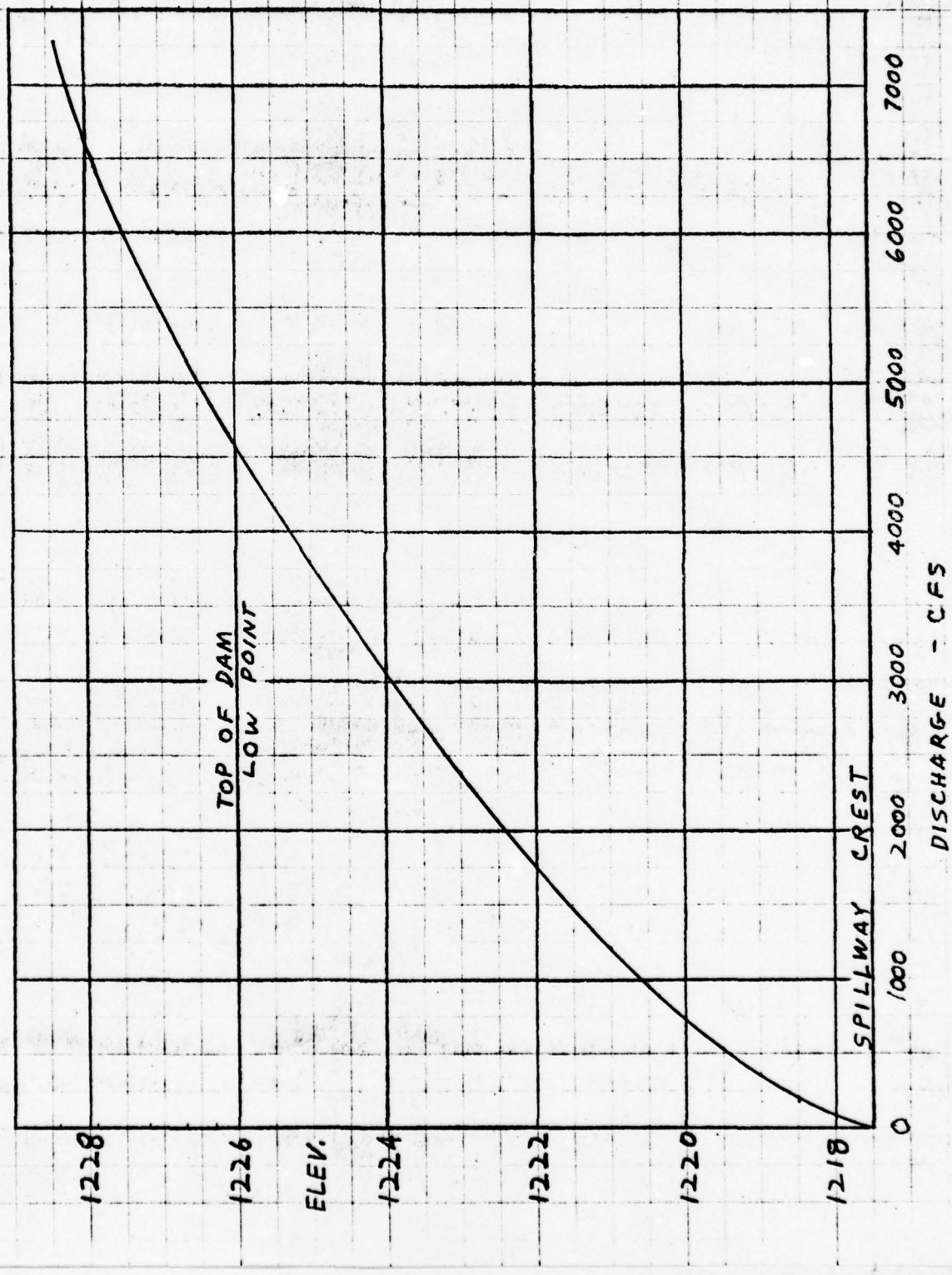
USE "HIGH"

RECOMMENDED SPILLWAY DESIGN FLOOD

THE ABOVE CLASSIFICATIONS INDICATE USE OF AN SDF EQUAL TO THE PROBABLE MAXIMUM FLOOD.

BY RLS DATE 5/24/ BERGER ASSOCIATES SHEET NO. 11 OF
CHKD. BY DATE PROJECT DB490
SUBJECT NESQUEHONING ATH HOLLOW DAM

DISCHARGE RATING CURVE



BY RLS DATE 5/24/79 | BERGER ASSOCIATES | SHEET NO. 13 OF
CHKD. BY DATE | PROJECT D8490
SUBJECT NESQUEHONING 4TH HOLLOW DAM

HEC-1 DATA

DRAINAGE AREA = 1.8 SQ. MI.

DELAWARE BASIN REGION 2
$C_P = 0.45$
$C_T = 2.1$
LONGEST WATER COURSE = 1.88 MI.
L TO CENTROID = 0.96 MI.

$T_P = C_T (L \times L_{CA})^{.3}$
$T_P = 2.51$

RAINFALL (HMR-33)
INDEX = 22.6"

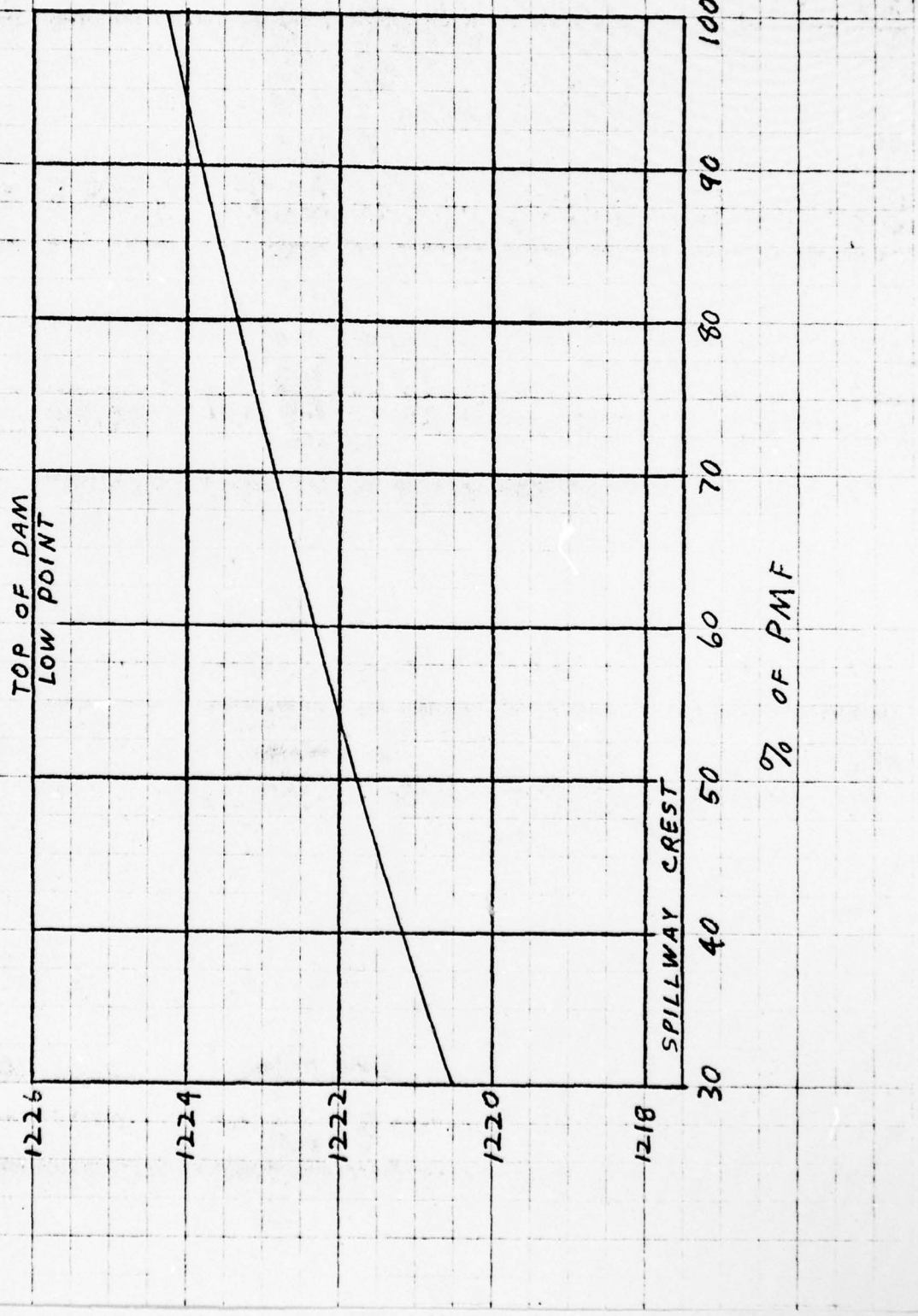
ZONE 6

INCREMENTAL RAINFALL
6 HR = 113 %
12 HR = 123 %
24 HR = 132 %
48 HR = 142 %

PLANIMETERED AREAS (FROM QUAD SHEET)
ELEV: 1217.5 = 6.1 ACRES
1240 = 19.1 ACRES
ZERO STORAGE ELEVATION
ELEV = 1217.5 - (STORAGE x 3/AREA)
= 1178.8

BY RLS DATE 5/24/79 BERGER ASSOCIATES SHEET NO. 11 OF
CHKD. BY DATE PROJECT D 8490
SUBJECT NESQUEHONING 4TH HOLLOW DAM

SPILLWAY CAPACITY CURVE



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 LAST MODIFICATION  26 FEB 79
 ********************************
    1              A1      NESQUEHONING 4TH HOLLOW RESERVOIR  DAM    ****    BROAD RUN
    2              A2      BOROUGH OF NESQUEHONING, CARBON COUNTY, PA.
    3              A3      NDI #  PA-00806     PA DER #  13-104
    4              B   300      0      15       0       0       0       0       0      -4       0
    5              B1    5
    6              J     1      9       1
    7              J1    1     .9      .8      .7      .6      .5      .4      .3     .15
    8              K             1                                      1
    9              K1                    INFLOW  HYDROGRAPH
   10              M     1       1     1.8                                              1
   11              P           22.6     113     123     132     142
   12              T                                                    1     .05
   13              W  2.51     .45
   14              X  -1.5    -.05       2
   15              K     1       2                                      1
   16              K1                    RESERVOIR  ROUTING
   17              Y                                    1       0
   18              Y1    1                                                79.8     -1
   19              Y41217.5    1218    1218.5    1219    1220    1221    1222    1223    1224    1225
   20              Y4  1226  1226.3    1226.7  1227.2  1227.9  1228.4
   21              Y5     0      65       185     340     731    1211    1766    2386    3066    3800
   22              Y5  4580    4837      5196    5682    6440    7280
   23              $A     0     6.1      19.1
   24              $E1178.3  1217.5      1240
   25              $$1217.5
   26              $D  1226
   27              K     99
1                          PREVIEW OF SEQUENCE OF STREAM NETWORK CALCULATIONS

                           RUNOFF HYDROGRAPH AT          1
                           ROUTE HYDROGRAPH TO           2
                           END OF NETWORK


1********************************
 FLOOD HYDROGRAPH PACKAGE (HEC-1)
 DAM SAFETY VERSION     JULY 1978
   LAST MODIFICATION  26 FEB 79
 ********************************

 RUN  DATE# 79/07/05.
      TIME# 13.35.26.


                           NESQUEHONING 4TH HOLLOW RESERVOIR  DAM    ****    BROAD RUN
                           BOROUGH OF NESQUEHONING, CARBON COUNTY, PA.
                           NDI #  PA-00806     PA DER #  13-104

                                                JOB SPECIFICATION
                        NQ      NHR     NMIN    IDAY     IHR     IMIN    METRC    IPLT    IPRT   NSTAN
                       300        0       15       0       0       0       0       0      -4       0
                                          JOPER     NWT   LROPT   TRACE
                                              5       0       0       0


                                    MULTI-PLAN ANALYSES TO BE PERFORMED
                                        NPLAN= 1 NRTIO= 9 LRTIO= 1
                              RTIOS=  1.00    .90     .80     .70     .60     .50     .40     .30     .15
```

BOROUGH OF NESQUEHONING, CARBON COUNTY, PA.
NDI # PA-00806 PA DER # 13-104

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
300	0	15	0	0	0	0	0	-4	0
			JOPER	NWT	LROPT	TRACE			
			5	0	0	0			

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 9 LRTIO= 1
RTIOS= 1.00 .90 .80 .70 .60 .50 .40 .30 .15

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

INFLOW HYDROGRAPH

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
1	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	1.80	0.00	1.80	0.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	22.60	113.00	123.00	132.00	142.00	0.00	0.00

TRSPC COMPUTED BY THE PROGRAM IS .800

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	1.00	.05	0.00	0.00

UNIT HYDROGRAPH DATA
TP= 2.51 CP= .45 NTA= 0

RECESSION DATA
STRTQ= -1.50 QRCSN= -.05 RTIOR= 2.00

UNIT HYDROGRAPH 90 END-OF-PERIOD ORDINATES, LAG= 2.52 HOURS, CP= .45 VOL= 1.00

6.	22.	46.	73.	104.	136.	165.	188.	204.	212.
210.	199.	187.	176.	165.	155.	146.	137.	128.	121.
113.	106.	100.	94.	88.	83.	78.	73.	69.	64.
61.	57.	53.	50.	47.	44.	42.	39.	37.	34.
32.	30.	29.	27.	25.	24.	22.	21.	20.	18.
17.	16.	15.	14.	13.	13.	12.	11.	10.	10.
9.	9.	8.	8.	7.	7.	6.	6.	6.	5.
5.	5.	4.	4.	4.	4.	3.	3.	3.	3.
3.	2.	2.	2.	2.	2.	2.	2.	2.	1.

0 END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q

SUM 25.67 23.28 2.40 107944.
(652.[illegible] 591.[illegible] 61.[illegible] 3056.43)

RESERVOIR ROUTING

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
2	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	0	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	80.	-1

STAGE	1217.50	1218.00	1218.50	1219.00	1220.00	1221.00	1222.00	1223.00	1224.00	1225.00
	1226.00	1226.30	1226.70	1227.20	1227.90	1228.40				
FLOW	0.00	65.00	185.00	340.00	731.00	1211.00	1766.00	2386.00	3066.00	3800.00
	4580.00	4837.00	5196.00	5682.00	6440.00	7280.00				

SURFACE AREA=	0.	6.	19.
CAPACITY=	0.	80.	350.
ELEVATION=	1178.	1218.	1240.

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
1217.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
1226.0	0.0	0.0	0.

PEAK OUTFLOW IS 3244. AT TIME 42.50 HOURS

PEAK OUTFLOW IS 2919. AT TIME 42.50 HOURS

PEAK OUTFLOW IS 2595. AT TIME 42.50 HOURS

PEAK OUTFLOW IS 2270. AT TIME 42.50 HOURS

PEAK OUTFLOW IS 1946. AT TIME 42.50 HOURS

PEAK OUTFLOW IS 1621. AT TIME 42.50 HOURS

PEAK OUTFLOW IS 1297. AT TIME 42.50 HOURS

PEAK OUTFLOW IS 972. AT TIME 42.50 HOURS

PE... OUTFLOW IS 486. AT TIME 42.50 HOURS

********** ********** ********** ********** **********

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS RATIO 1 1.00	RATIO 2 .90	RATIO 3 .80	RATIO 4 .70	RATIO 5 .60	RATIO 6 .50	RATIO 7 .40	RATIO 8 .30	RATIO 9 .15
HYDROGRAPH AT	1	1.80	1	3257.	2931.	2605.	2280.	1954.	1628.	1303.	977.	489.
	(	4.66)	(	92.22)(	83.00)(	73.78)(	64.55)(	55.33)(	46.11)(	36.89)(	27.67)(	13.83)
ROUTED TO	2	1.80	1	3244.	2919.	2595.	2270.	1946.	1621.	1297.	972.	486.
	(	4.66)	(	91.86)(	82.66)(	73.48)(	64.28)(	55.10)(	45.90)(	36.73)(	27.53)(	13.75)

1 SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1217.51	1217.50	1226.00
STORAGE	80.	80.	148.
OUTFLOW	1.	0.	4580.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	1224.24	0.00	131.	3244.	0.00	42.50	0.00
.90	1223.78	0.00	127.	2919.	0.00	42.50	0.00
.80	1223.31	0.00	123.	2595.	0.00	42.50	0.00
.70	1222.81	0.00	118.	2270.	0.00	42.50	0.00
.60	1222.29	0.00	114.	1946.	0.00	42.50	0.00
.50	1221.74	0.00	109.	1621.	0.00	42.50	0.00
.40	1221.16	0.00	105.	1297.	0.00	42.50	0.00
.30	1220.50	0.00	100.	972.	0.00	42.50	0.00
.15	1219.37	0.00	92.	486.	0.00	42.50	0.00

1**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION JULY 1978
LAST MODIFICATION 01 FEB 79

APPENDIX D

GEOLOGIC REPORT

GEOLOGIC REPORT

Bedrock - Dan and Reservoir

Formation Name: Clark Ferry Member, Catskill Formation.

Lithology: Gray to grayish red, medium to coarse grained, cross-bedded quartzite and sandstone, interbedded with minor grayish red siltstone and shale.

Structure

The dam is located on the south flank of the Broad Mountain Anticline. The beds here strike N65°E and dip 57°SE. No faults are mapped at the site, but the valley of Broad Run at the site is probably parallel to fractures.

Overburden

The overburden at the dam site varied from 0 to 13 feet thick and consisted of soil, sand and boulders. Much of the site was bedrock outcrop.

Aquifer Characteristics

The bedrock is essentially impermeable and ground water movement is along bedding planes and fractures. Principal movement at the dam site is probably along the set of fractures which parallel the valley.

Discussion

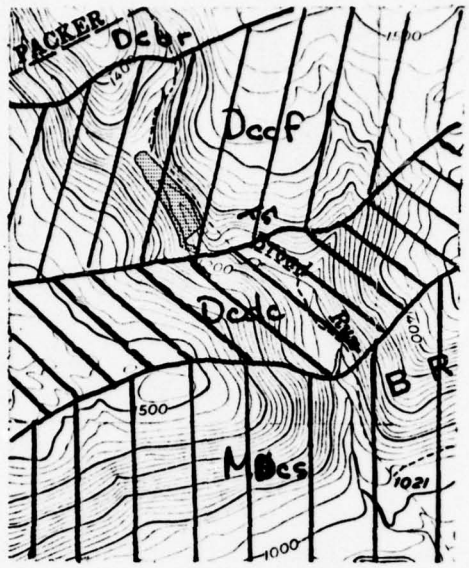
The cutoff trench for this dam is in fresh rock, and grouting was carried out. Some leakage is possible along fractures which are at right angles to the dam axis, but the rock is sound and it is unlikely that continued leakage would cause deterioration of the foundation.

Sources of Information

1. Wood, G.H., Jr. (1974). "Geologic Map of the Nesquehoning Quadrangle". U.S. Geological Survey Map GQ 1132.

2. Core borings in file.

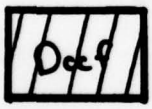
GEOLOGIC MAP- Nesquehoning Fourth Hollow Dam



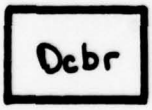
(geology from U.S.G.S. Map GQ-1132)

Catskill Fm.- Spechty Koft Member

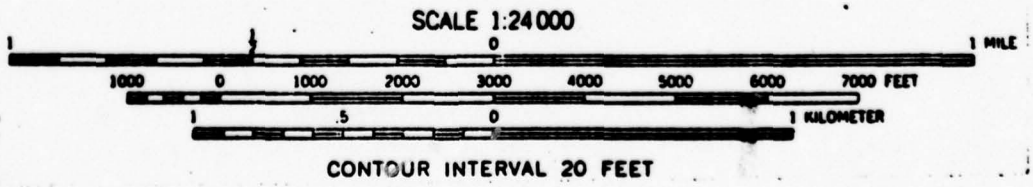
Catskill Fm.- Duncannon member



Catskill Fm.- Clarks Ferry Member



Catskill Fm.- Berry Run Member



APPENDIX E

PHOTOGRAPHS

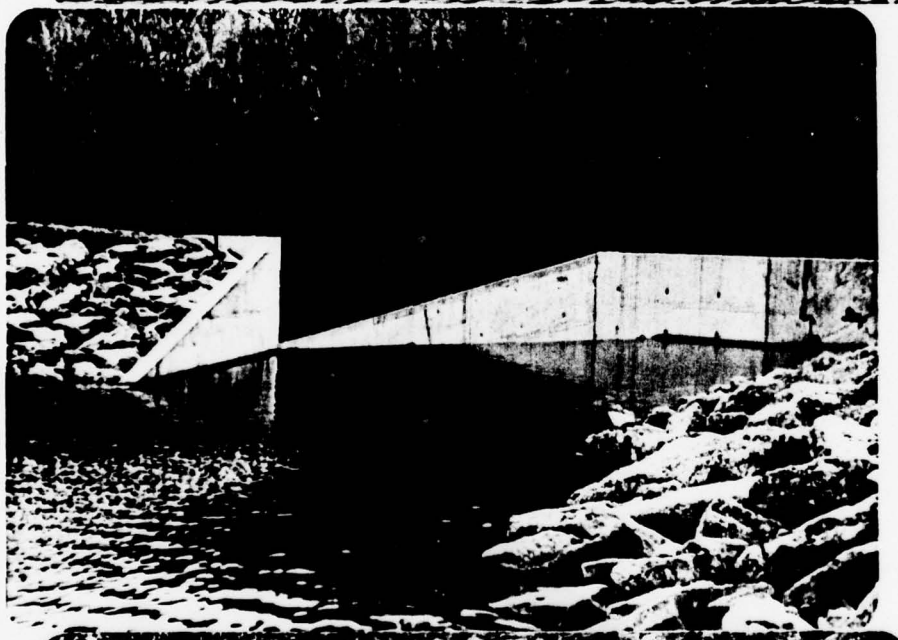
View of Dam. Spillway in background.

Bridge to intake Structure.

Conduit Outlet with Concrete Enclosure

PA-806
PLate E-I

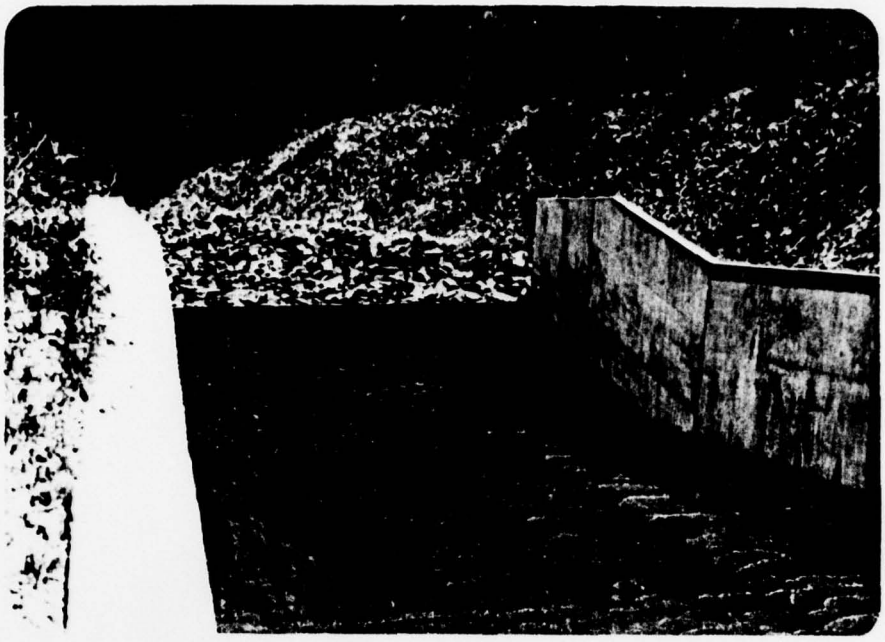
Forebay Area



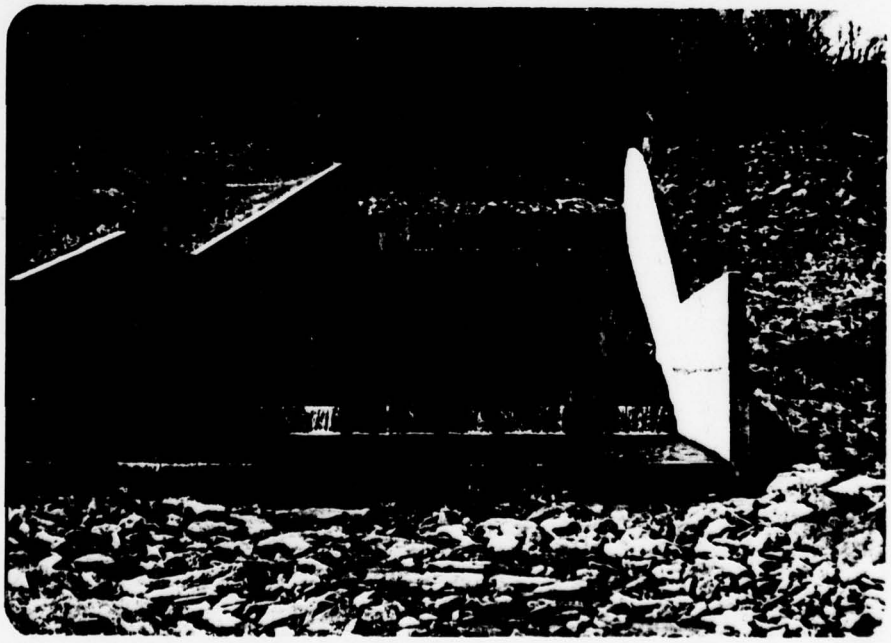
Detail forebay
Walls

Spillway Ogee
Section

PA-806
Plate E-II



Stilling Basin & Downstream Channel

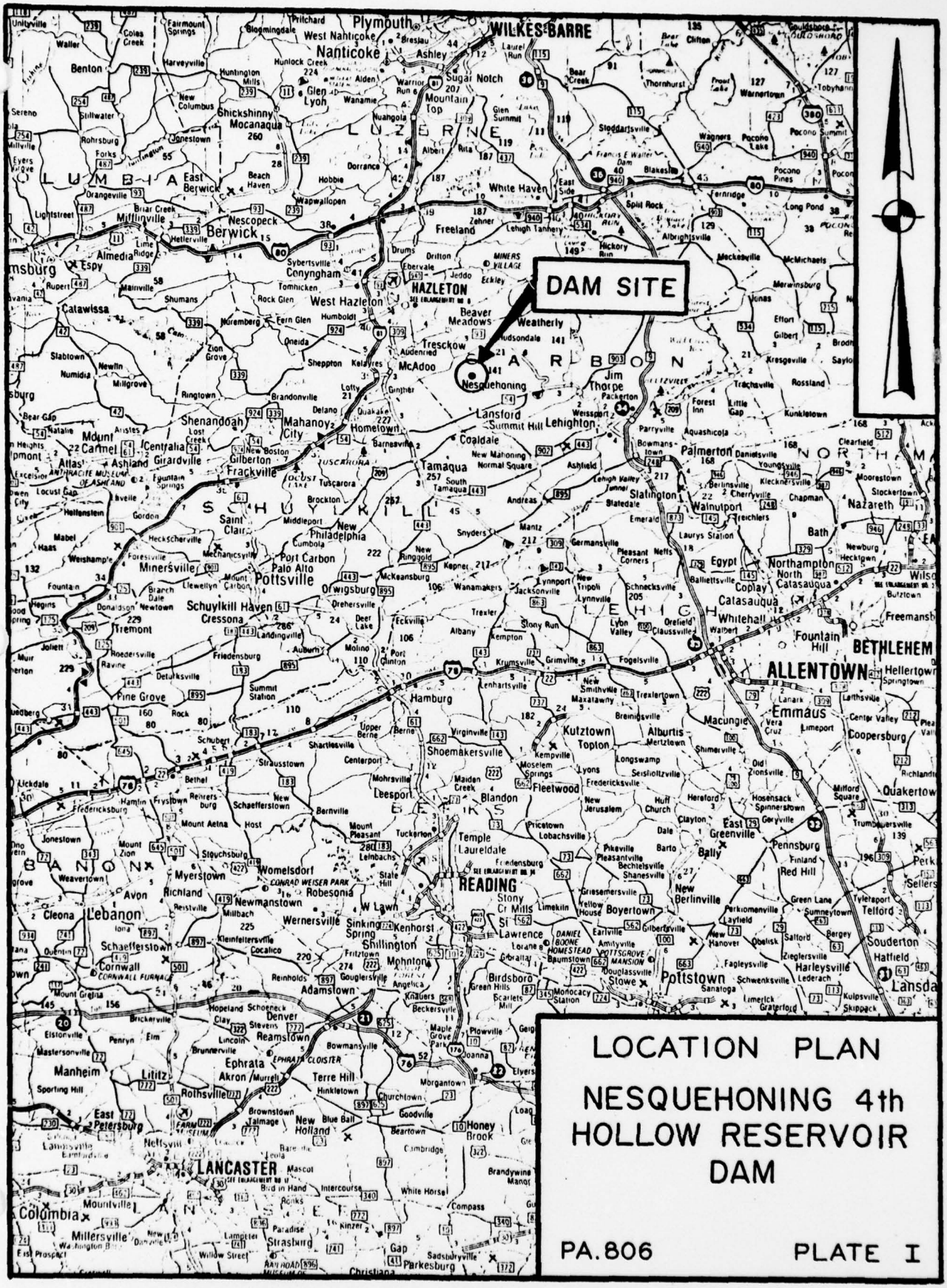


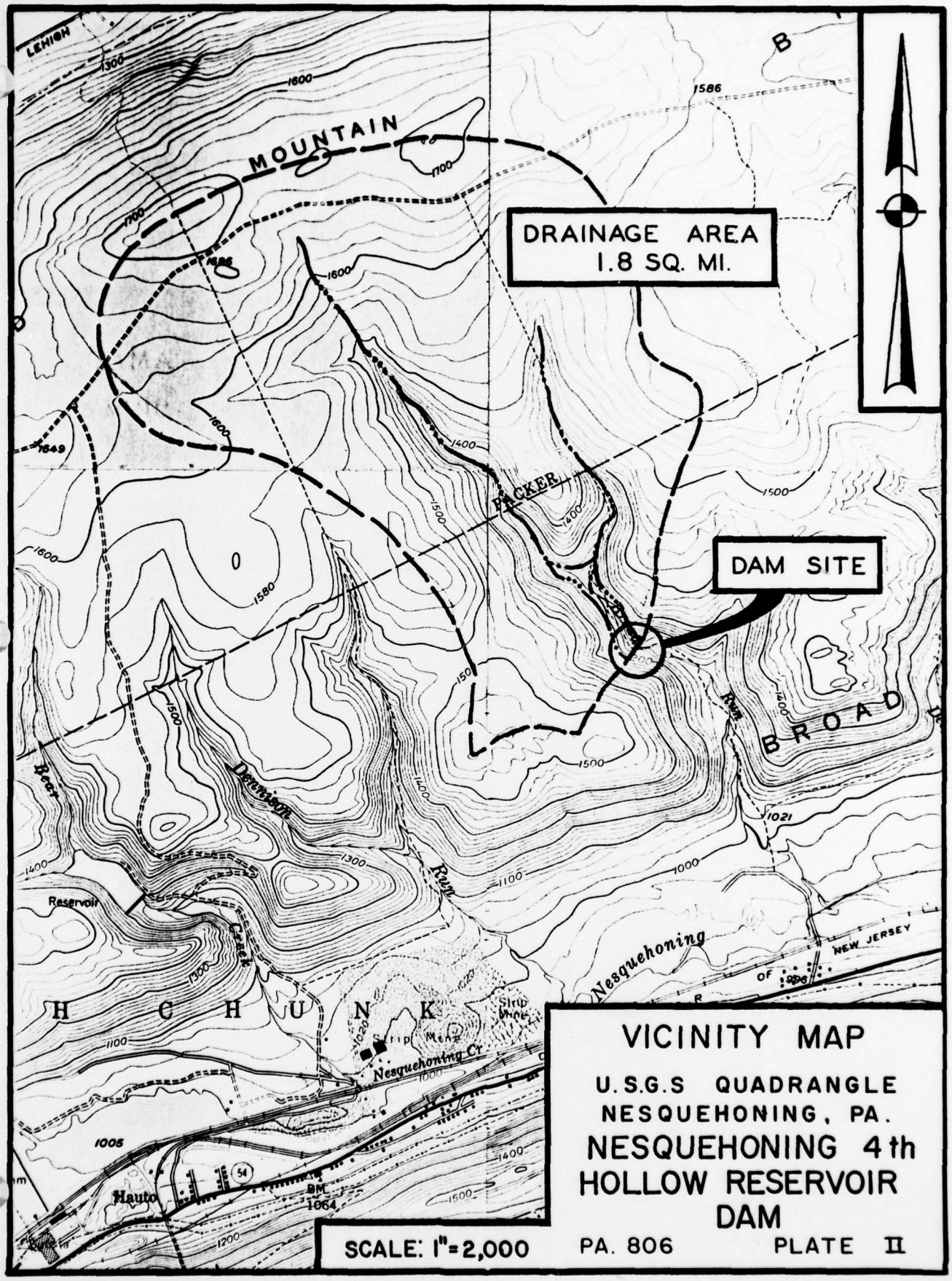
Spillway Chute looking upstream

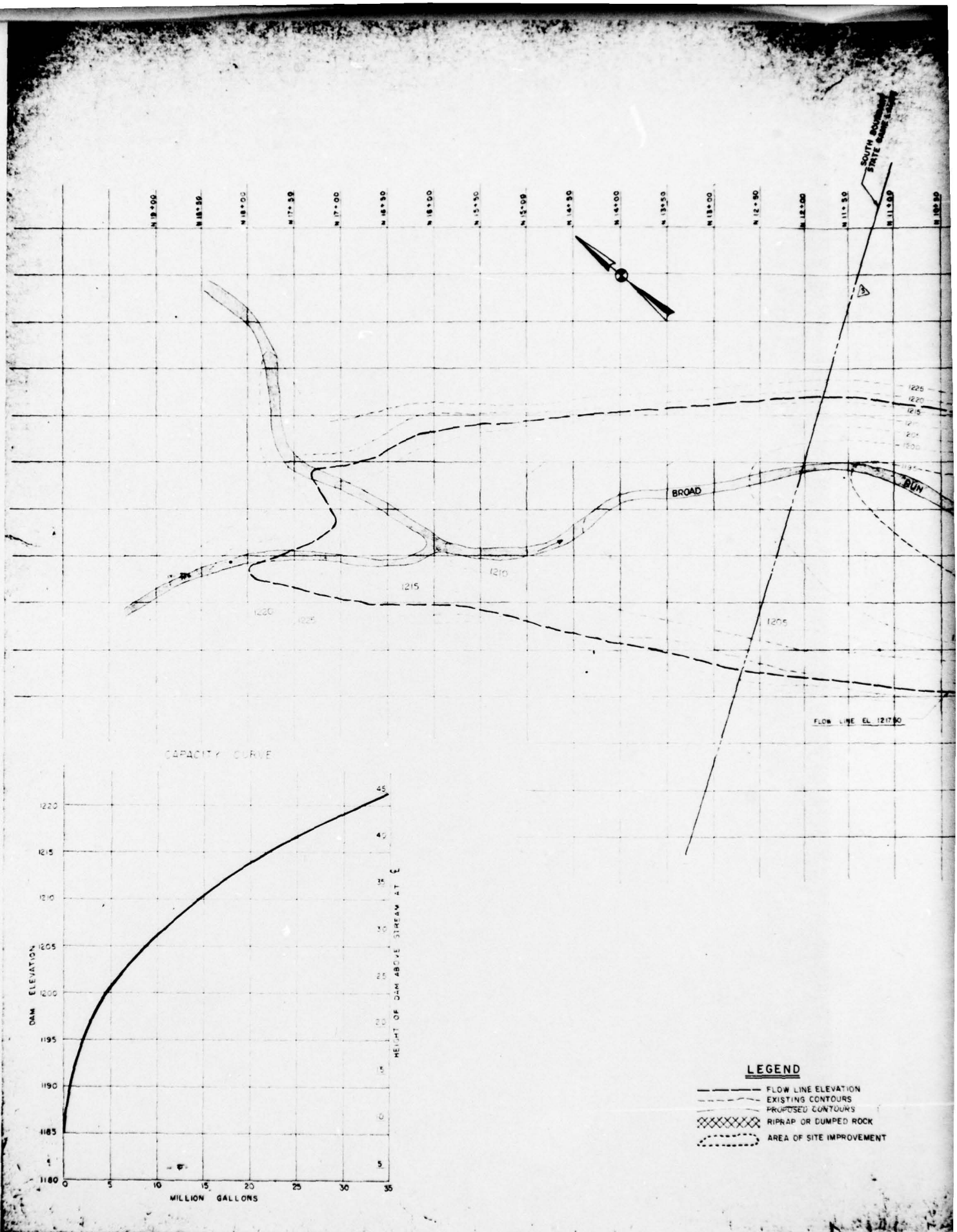
PA-806
Plate E-III

APPENDIX F

PLATES


DAM SITE
LOCATION PLAN
NESQUEHONING 4th
HOLLOW RESERVOIR
DAM
PA. 806
PLATE I


DRAINAGE AREA
1.8 SQ. MI.
DAM SITE
MOUNTAIN
PACKER
Run
BROAD
Dennison
Run
Reservoir
Creek
H C H U N K
Nesquehoning Cr
Nesquehoning
NEW JERSEY
Hauto
BM
1064
1005
1021
1586
1649
1620
1580
1600
1500
1400
1300
1200
1100
1000
LEHIGH
B
VICINITY MAP
U.S.G.S QUADRANGLE
NESQUEHONING, PA.
NESQUEHONING 4th
HOLLOW RESERVOIR
DAM
SCALE: 1"=2,000
PA. 806
PLATE II

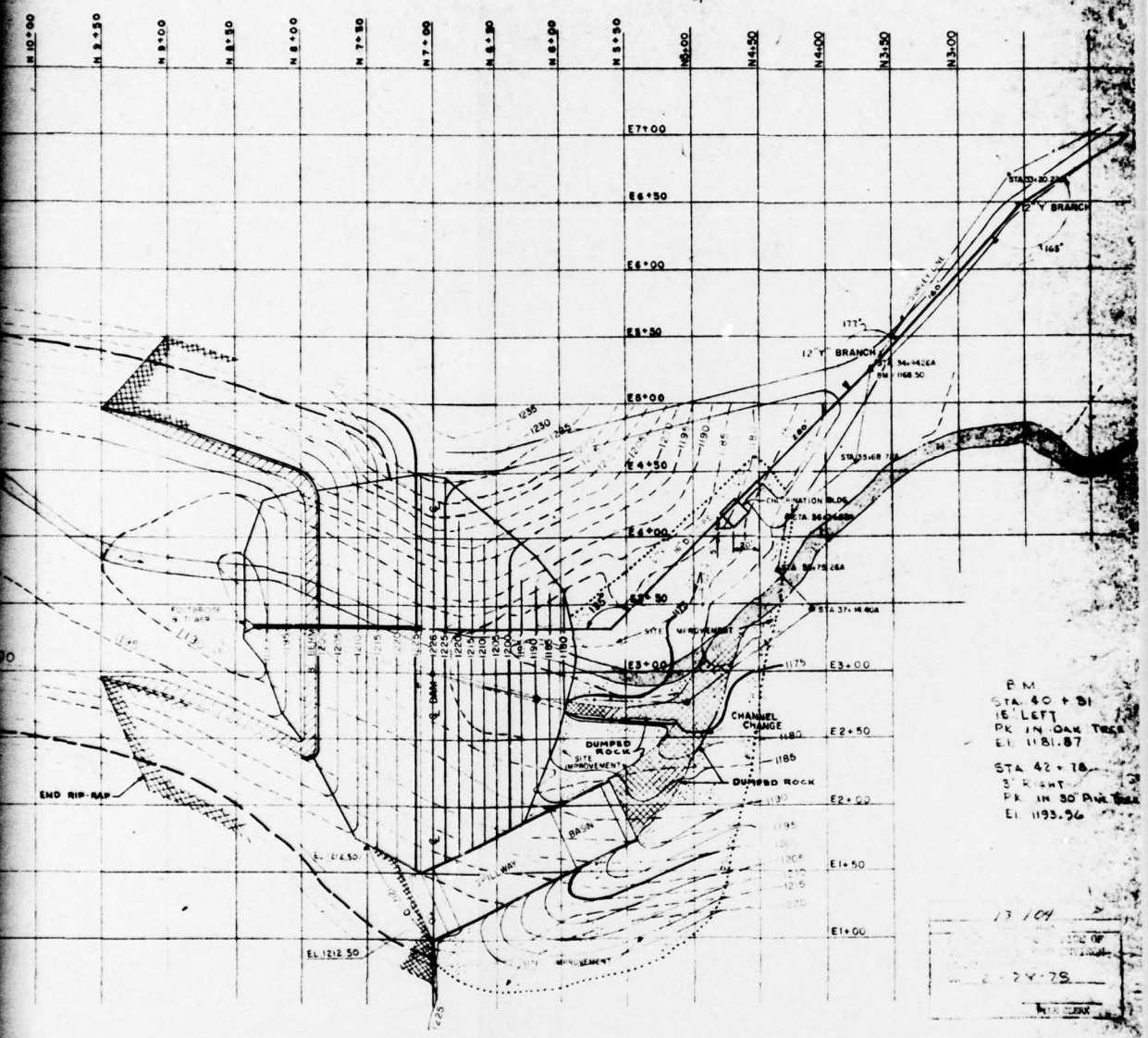


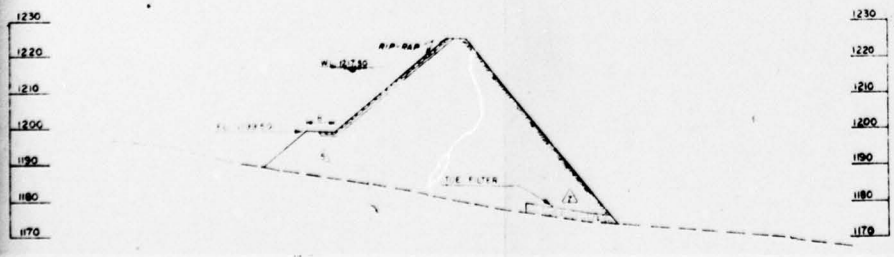
CAPACITY CURVE

LEGEND

- FLOW LINE ELEVATION
- EXISTING CONTOURS
- PROPOSED CONTOURS
- RIPRAP OR DUMPED ROCK
- AREA OF SITE IMPROVEMENT

PA. 80
PLATE III





PROFILE 3+00
HOR: 1"=50'
VER: 1"=20'

	REVISIONS
5	ADDED TOE FILTER
6	RELOCATED FOOTBRIDGE & TOWER
4	DOWNSTREAM SLOPE OF DAM CHANGED, LINER REMOVED, BERM RELOCATED, DRAINAGE CULVERT RELOCATED, RIP-RAP ON LOWER HALF OF DAM REMOVED
3	PROJECT AREA CHANGED
2	ADDED GAME LANDS
1	ADDED TRANSFORMER & TOWER, REVISED ELECTRIC LINE

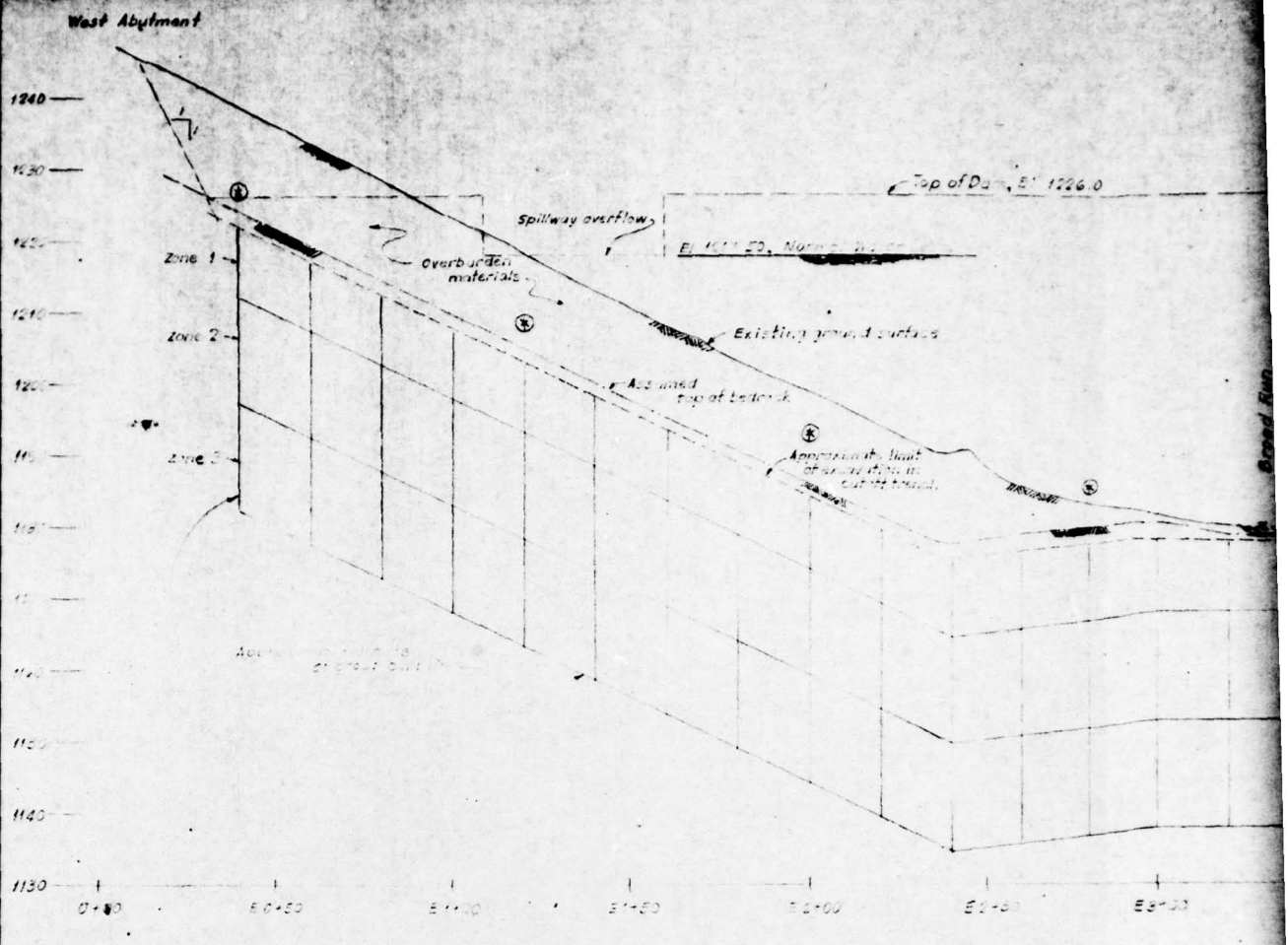
WATER SUPPLY SYSTEM

PLAN OF RESERVOIR

BOROUGH OF NESQUEHONING CARBON COUNTY
PENNSYLVANIA

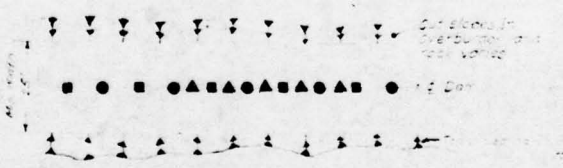
SCALE 1"=50'

G. L. WIESENBERGER & ASSOCIATES, INC.
CONSULTING ENGINEERS



PROFILE ALONG ℄ OF DAM

SCALE
HORIZONTAL 1" = 50'
VERTICAL 1" = 10'

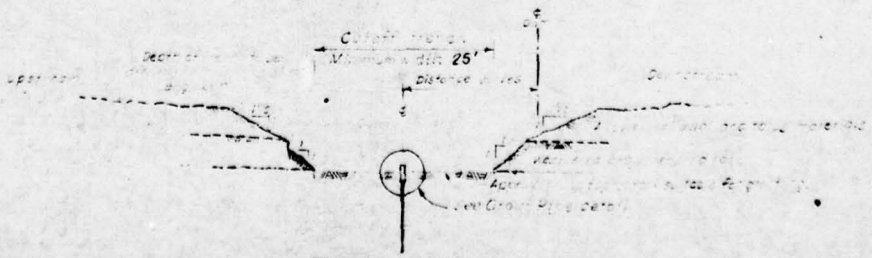


GROUT PLAN

SCALE: 1" = 20'

LEGEND

- PRIMARY GROUT HOLES
- SECONDARY GROUT HOLES
- TERTIARY GROUT HOLES

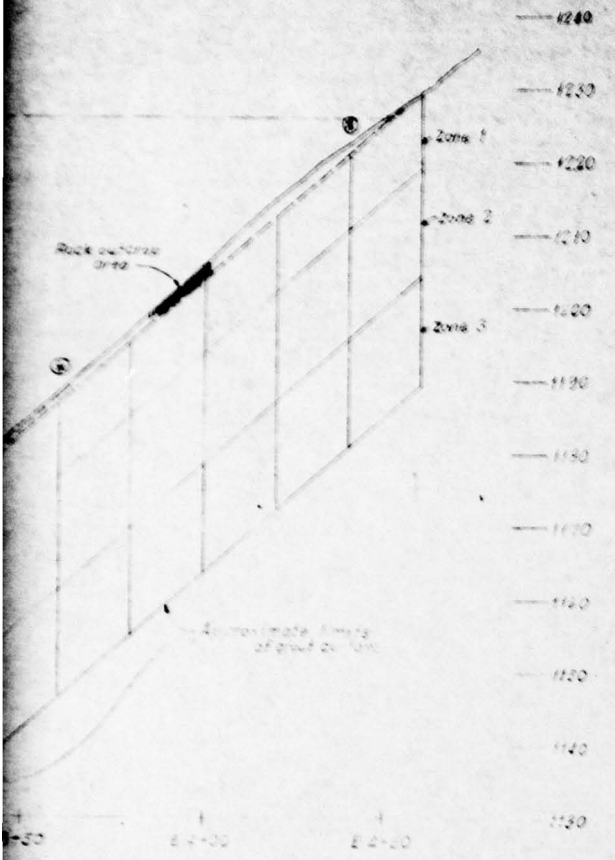


TYPICAL SECTION
CUTOFF TRENCH
SCALE: 1" = 10'

Notes:

1.
2. Exter
3.
4. Bed
5.

East Abutment



GROUT ZONES

Zone 1 - Trench bottom to 10' depth
Zone 2 - 10' to 25' depth
Zone 3 - 25' to 40' depth

GROUT HOLE DETAIL

SCALES: 1" = 5'

...ing, location and depths of grout holes may be changed by the geological or ... found during boring operations.

...pipe 1 foot long may be required for Zone 1 grouting, as needed, and shall be ...e made prior to gravity grouting.

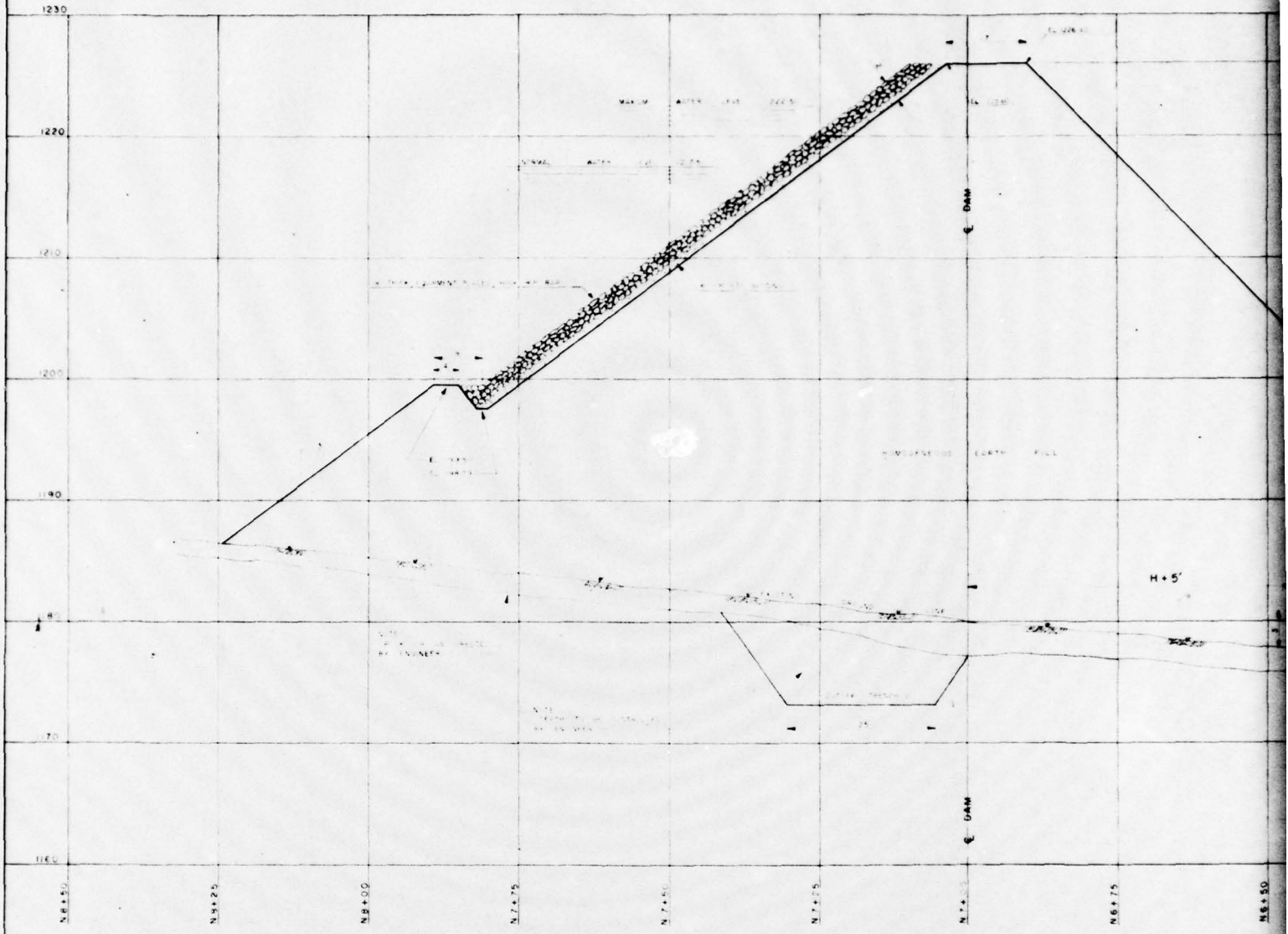
...ut holes shall be drilled and grouted on 20' centers, secondary holes shall be ...grouted to split the spacing of the primary holes. If determined necessary ...ext or even finer, tertiary and higher order grout holes shall be drilled by the ...ne method.

...rey quartzitic sandstone and red shale. See logs of borings, sheet ____.

...ry holes to be drilled at locations marked (X). All exploratory ...rilled vertically to 50' depths unless directed otherwise.

WATER SUPPLY SYSTEM		
GROUTING DETAILS BOROUGH OF NESQUEHONING CARBON COUNTY PENNSYLVANIA		
SCALE AS NOTED	A.L. WIEGMANN ASSOCIATES, INC. CONSULTING ENGINEERS ALLENTOWN PENNSYLVANIA	PROJECT NO. 74004
DESIGNED BY		DATE
DRAWN BY		SHEET NO. OF

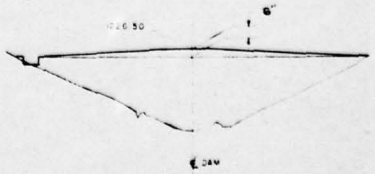
PA. 806
PLATE IV



GRADATION REQUIREMENT
FOR TOE FILTER &
RIP RAP BEDDING

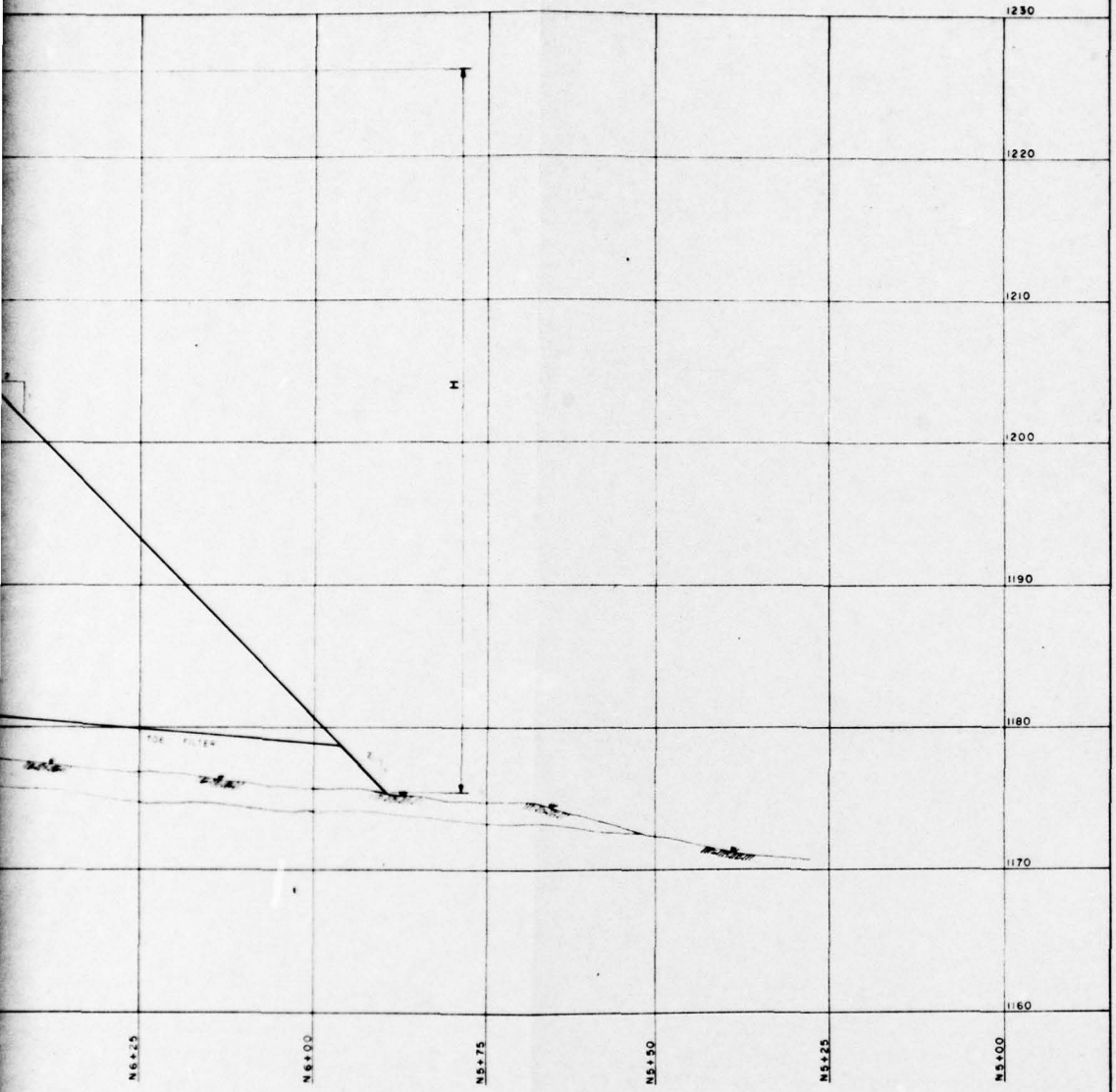
ZE	% PASSING
1"	100
1/2"	90-100
1/4	75-95
1/8	60-80
#4	45-70
#8	30-55
#16	20-40
#30	0-25
#50	5-15
#100	<8
#200	<3

SCALE
HORZ 1" = 10'
VERT 1" = 5'



CAMBER DETAIL

NOTE
DURING CONSTRUCTION DAM IS TO BE BUILT TO AN ELEVATION OF 1226.50 AT ITS CENTERLINE TO ALLOW FOR SETTLEMENT.



NOTE
IT SHALL BE THE CONTRACTORS RESPONSIBILITY TO PROVIDE THE EMBANKMENT MATERIAL FROM AN APPROVED SOURCE AND THAT THE MATERIAL SHALL CONFORM TO THE REQUIREMENTS OF THE SPECIFICATIONS CONCERNING MOISTURE, WEIGHT AND TYPE MATERIAL SPECIFIED.

13 104
ON 2-28-77
FILED

MARK	REVISIONS	DATE
	SHEET DRAWN	7-28-72

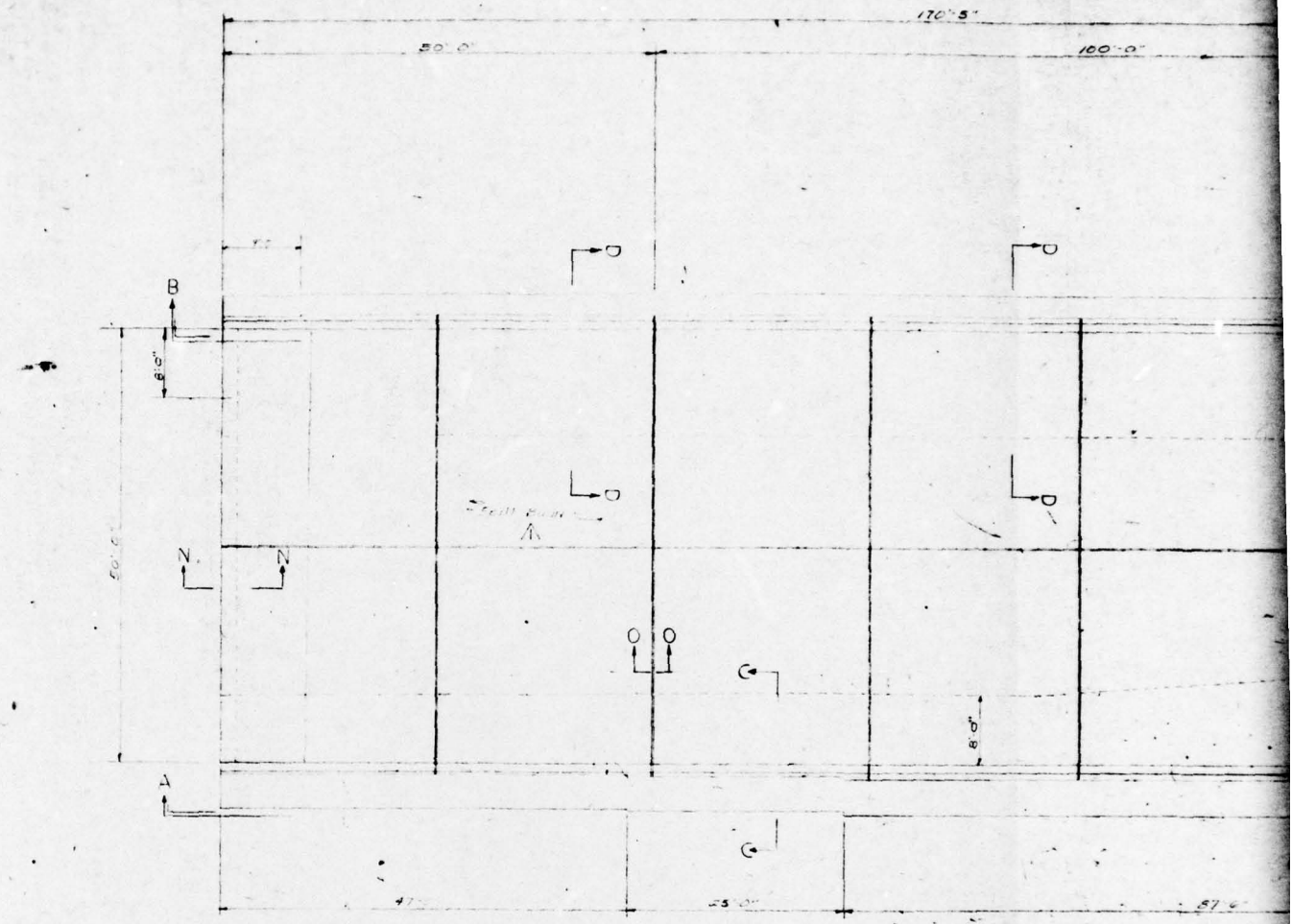
WATER SUPPLY SYSTEM

CROSS SECTION OF DAM AT E3+00

BOROUGH OF NESQUEHONING CARBON COUNTY
PENNSYLVANIA

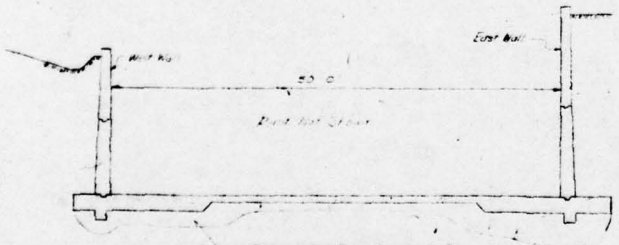
SCALE AS NOTED	A.L. WIESENBERGER ASSOCIATES, INC. CONSULTING ENGINEERS ALLENTOWN HARRISBURG PENNSYLVANIA	PROJECT NO. 28002
DWN. BY PWB		DATE MARCH,
CHD BY		SHEET 8 OF

PA. 806
PLATE V



PLAN

SCALE 1/8" = 1'-0"

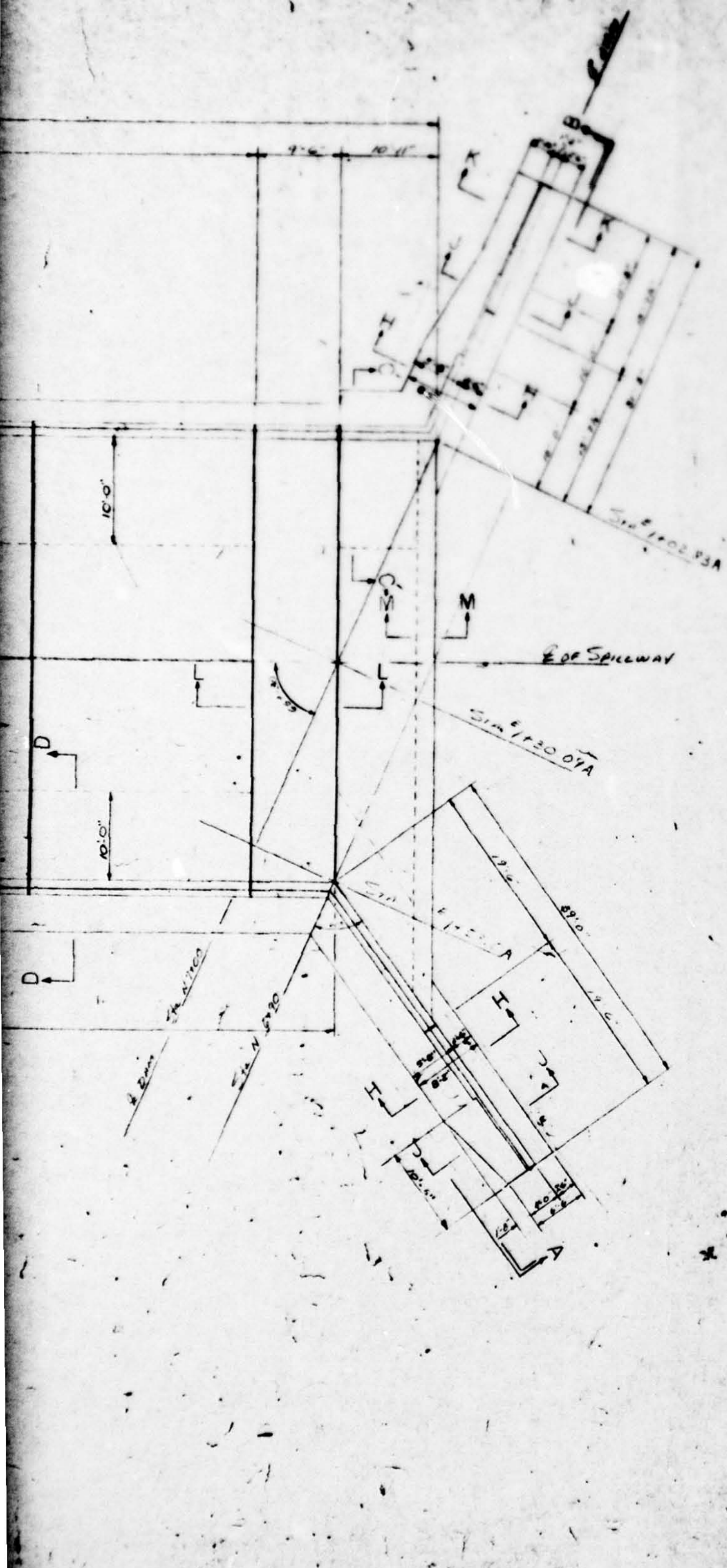


EXCAVATION TO BE CARRIED TO FIRM FOUNDATION AND BACKFILLED WITH FILTER MAT'L. SEE SECTION 5.16 OF CONSTRUCTION SPECIFICATION. MIN. FILL TO BE 12" IN DEPTH.

TYPICAL SECTION

SCALE 1/8" = 1'-0"

NOTE
SEE TYPICAL SECTION - SHEET 14
FOR LIMIT OF EXCAVATION
INCLUDED UNDER BID ITEM NO. 2



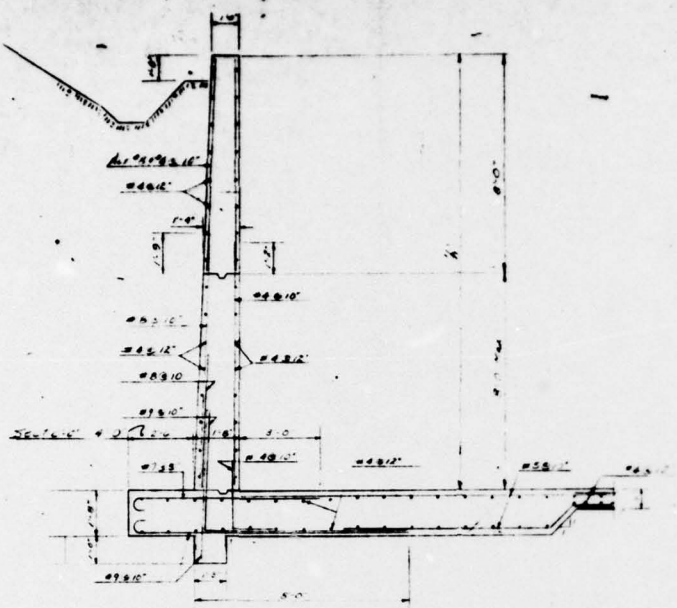
WATER SUPPLY SYSTEM

PLAN OF SPILLWAY

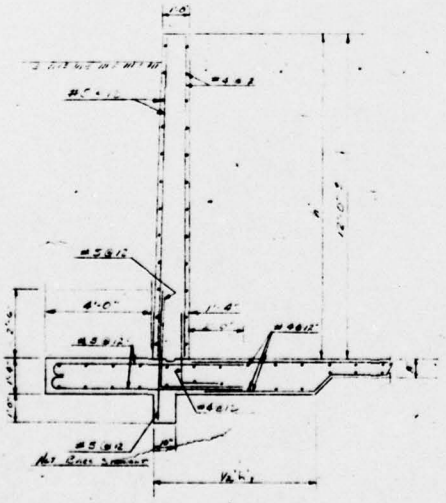
BOROUGH OF [illegible]

PA. 806 9

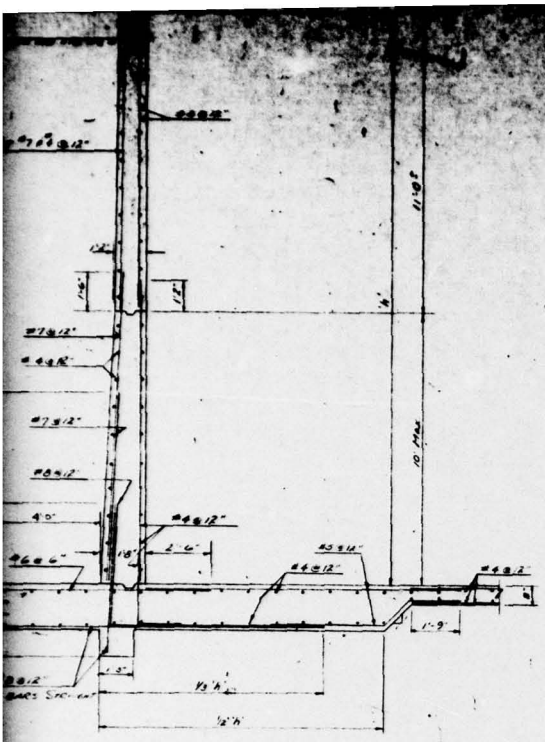
PLATE VI



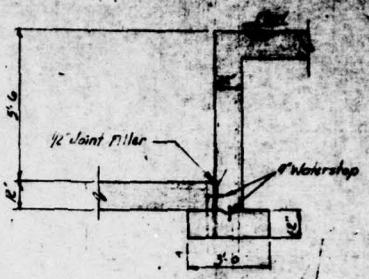
SECTION C-C
SECTION C'-C'
3/8"=1'-0"



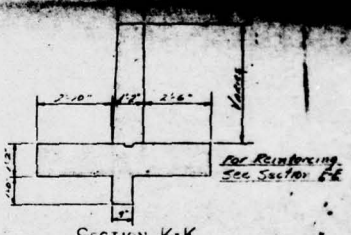
SECTION E-E
3/8"=1'-0"



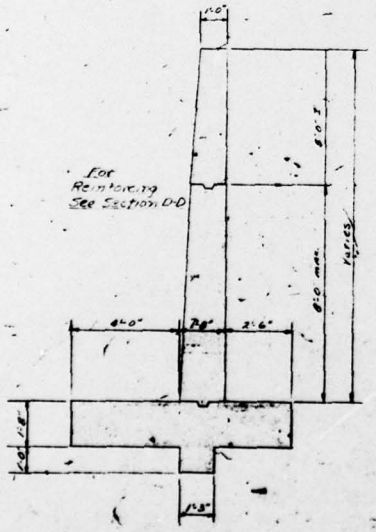
SECTION D-D
3/8"=1'-0



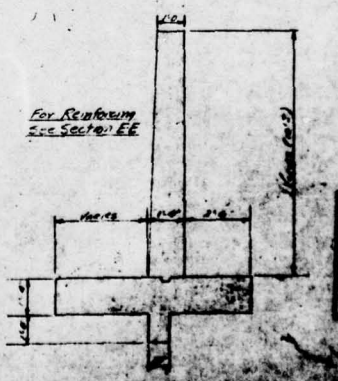
SECTION O-O
3/8"=1'-0



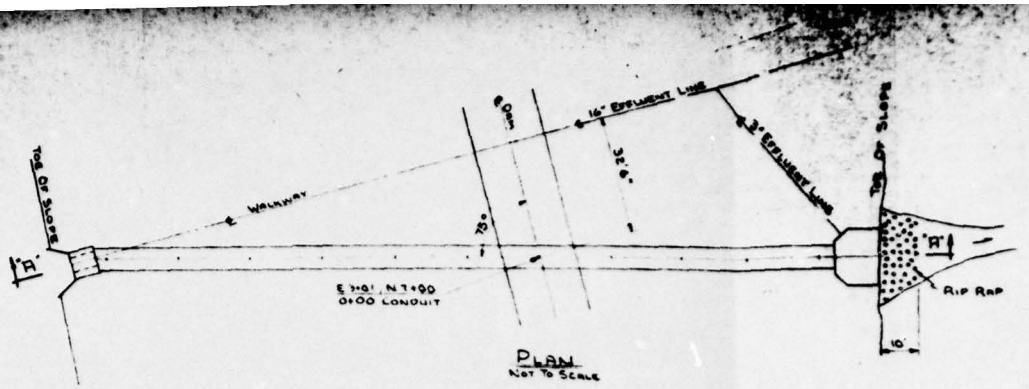
SECTION K-K



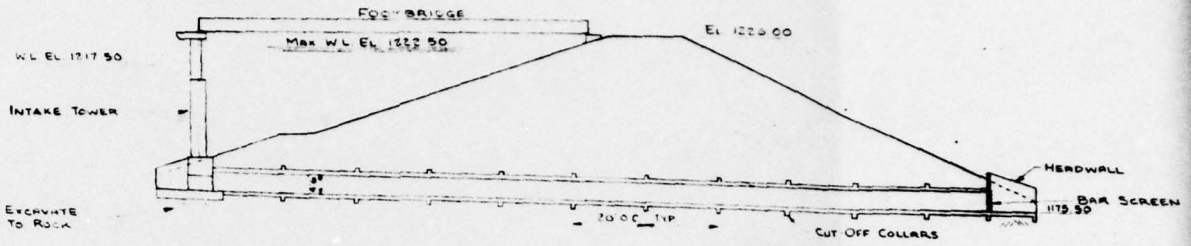
SECTION H-H
3/8"=1'-0



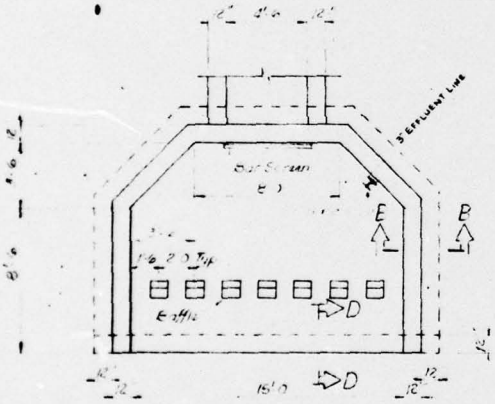
PL. 806
PLATE



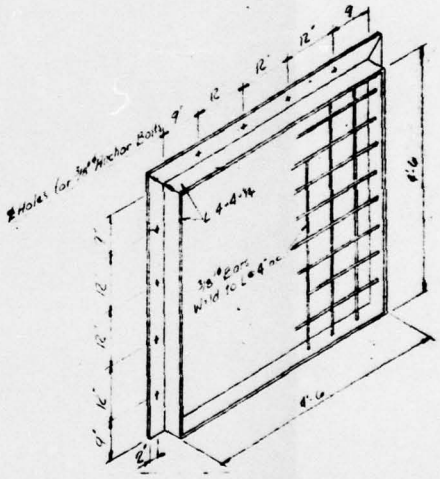
PLAN
Not To Scale



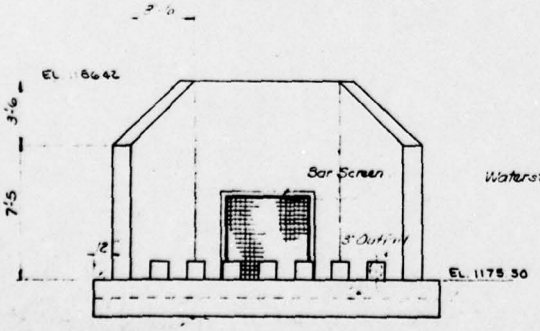
SECTION A A
Not To Scale



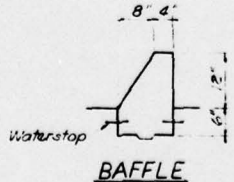
PLAN
3/16"=1'-0



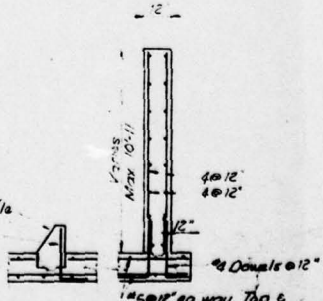
BAR SCREEN
3/4"=1'-0



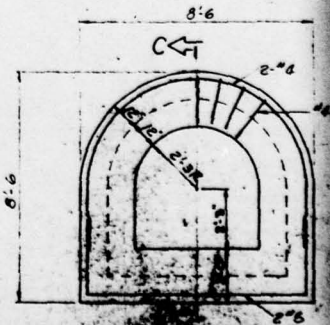
ELEVATION
3/8"=1'-0



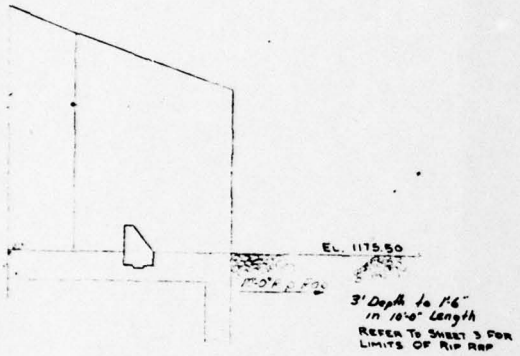
BAFFLE
3/4"=1'-0



SECTION BB
3/8"=1'-0

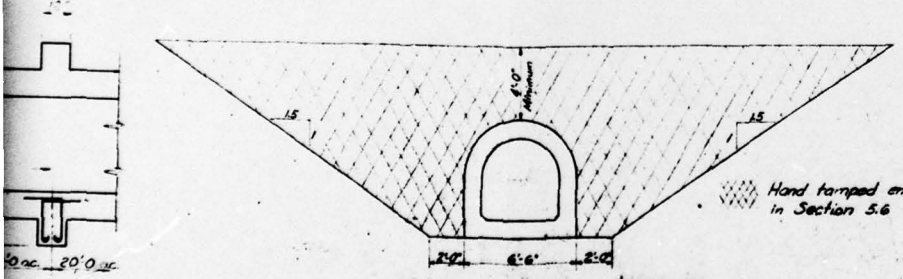


OUTLET STRUCTURE FOR CULVERT



SECTION D-D

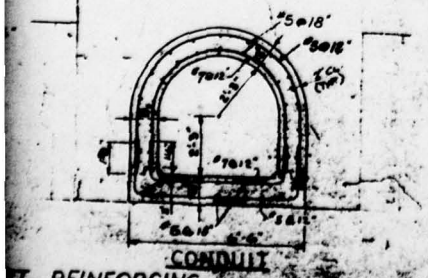
PA. 806
PLATE VIII



Hand tamped embankment in 4" layers, as specified in Section 5.6 of the Specifications.

CONDUIT EMBANKMENT
1/4"=1'-0"

CTION C-C
3/8"=1'-0



CONDUIT

T REINFORCING

17-104
FILE NUMBER
RECEIVED IN THE OFFICE OF THE DEPARTMENT OF ENVIRONMENTAL RESOURCES
ON 2-28-77
FILE CLERK

1	Revised & Redrawn
2	Project No. Changed
3	[illegible]
4	[illegible]
No.	Revisions

WATER SUPPLY SYSTEM

DETAILS

2